POWER

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Sword Carrying

TIME WAS, and not so long ago, when everybody of any account carried a sword.

The practice held over long beyond the time when it was necessary as a means of defense; and the handiness of a weapon, rivalry in its skillful exercise, and an exaggerated sense of honor—easily affronted—led to the sacrifice of more lives by this condition of preparedness than would have been lost without it.

I can see how any movement for the discontinuance of the custom would have aroused aggrieved opposition. Were gentlemen to be despoiled of their distinctive privilege and confounded with artisans and tradesmen? Was an age-old industry with its celebrated masters, its army of craftsmen and distributors to be laid low? Were citizens, defenseless because of their peaceful habits, to be denied means of resistance to thugs and marauders? Were matters touching one's sacred honor to be left to courts which might be open to venal approaches or under the influence of the aggressor? Was the implement of the gentlemanly art of fencing, the emblem of knighthood, the badge of chivalry, to be consigned to the scrap heap in an attempt to realize a Utopian dream of universal good-will and absence of lawlessness?

A sword now-a-days is of as much and of the same kind of use as spurs on the heels of a commissary officer.

Even before firearms made them ineffective their carrying was abandoned through the realization of its ridiculousness in a civilized and well-ordered community.

People generally do not go armed today, notwithstanding sporadic hold-ups and violence. They have an abiding faith in the soundness and security of established good intention and organized morality.

How long will it take for them to get into the same state of mind nationally and internationally?

How long will the world tolerate rulers whose ambition is to enhance their own and their nation's importance by the conquest and subjugation of other nations?

How long will people be willing to spend a large proportion of their national income to equip and maintain paraphernalia for their rulers to play with or to repel their enemies' onslaughts?

How long will men submit to the overstressing of patriotism, national cockiness and greed, and the machinations of those to whom war is a trade and an opportunity to keep alive that dread which, next to that of disease and impoverishment, is still the greatest incubus upon human contentment and security?

F. R. Low

EDITORIALS

Consider the Losses Outside the Plant

IN CONSIDERING how to improve the efficiency and reduce the cost of power generation, the application of the power should be given thought. It is of little use to save five per cent in the power plant if a loss of twenty per cent beyond the busbars and the process-steam header is permitted. It is easy to lose sight of what happens to the power after it leaves the busbars, while interruptions are not too frequent.

The possibilities of saving in power applications are many. First, the system must be correctly designed. If electrical feeders are undersized, transformers improperly located, and motors unsuited to their services, revamping is the only remedy. Even in a well-laid-out distribution system the losses may be high if the equipment is not properly maintained. Then, too, such things as shafting and machinery out of alignment, leaky valves on pumps and compressors, poor insulation of electrical equipment, and machinery left running when not in use, are sources of loss that accumulate into a surprising total.

In some plants the necessity of meeting maximum demand is a source of considerable loss, although not generally considered as such where power is privately generated. With certain classes of load, the maximum demand may be readily controlled. Where this is done, the saving in power losses is considerable, and other operating economies result. Reducing the maximum demand fifty per cent reduces the operating losses proportionately.

Systematic testing and the keeping of records of the condition of equipment may reveal unsuspected losses in application. Experience has shown that such tests pay substantial dividends in power savings, and reduction in maintenance, and prevent interruption to service.

Reduction of power and heat losses begins at the coal pile and ends with the finished product. To neglect any step in the generation, transmission and utilization of power and heat may allow expensive leaks to go unnoticed.

Legal Status of Natural Gas Lines

WITH the rapid growth of pipe line transmission for natural gas it is probable that many new legal questions will require adjustment by adjudication and otherwise to safeguard the interests of all concerned.

The Couzens bill, which seeks to authorize the Federal Power Commission to regulate interstate commerce in power will be interesting reading to gas pipe line companies, for the transmission of natural gas is similar to that of electricity in many of its aspects.

Then, too, the status of gas pipe lines as common carriers will probably require clarification, for pressure in this direction may be expected from independent producers seeking to market their gas supplies.

Much of the natural gas is in control of the public utilities. This will involve interstate rate-fixing, and the conflict of interest in different states will require adjustment.

At present the fabric of natural gas utilization is so plastic and the alignment of business and economic forces so rapid that it is futile to prophesy. Yet it is certain that the future treatment of the natural gas interests by the constituted authority of the people, namely, the courts, will be greatly simplified and more harmonious if the financial and business interests will apply past experience to the present situation.

Boiler Drum Diameters With High Pressure

THE extraordinary development in steam generation during the last ten years has manifested trends which, at times, have been accepted as forecasting ultimate practice, only to have new factors enter and upset predictions.

When lower pressures dominated it was usual to provide boilers of the horizontal water-tube type with two or three large longitudinal drums. These afforded considerable water storage. Higher pressures brought

into wider use boilers of the cross-drum type, with a tendency to keep down the drum diameters in order to hold the plate thicknesses to reasonable limits, especially with riveted construction. Then came the prediction, often heard in engineering discussions, that drums would be smaller and smaller with the increase of pressures and that ultimately steam and water headers would replace them. If boilers operating at extremely high pressures with forced circulation be excepted, this forecast has not been borne out by more recent installations.

With water walls in many cases applied to all sides of the furnace, and a greater proportion of the heat thus absorbed by radiation, new factors were introduced. The wall tubes may, at times, deliver as high as eighty per cent steam and twenty per cent water. Under such conditions, when burning oil, gas, or pulverized coal, a sudden drop in load will greatly decrease the heat absorption, and the volume formerly occupied by steam must be filled by water from the drums. This will take most of the water from small drums.

Consequently, opinion appears to be changing in favor of the larger drums, and in many of the later installations large drums or several drums are preferred in order to provide the necessary water reserve. So it is seen that the art of steam generation is still developing, and it is not well to draw definite conclusions from current examples.

A Wall That Pays No Dividends

THE traditional wall between boiler room and turbine room has largely outlived its usefulness. When ash dust, coal dust and soot were inevitable byproducts of boiler operation it served a purpose that justified its cost. Practically dustless operation is possible with improved boiler room design, and the wall becomes, in many cases, a positive hindrance to effective operation.

Starting years ago, a few plants—chiefly oil- or gas-fired—omitted the wall and suffered no damage thereby. More recently several central stations have been constructed without dividing walls. The results have been so satisfactory that further extension of this practice is probable.

In addition to the saving in building cost—an important matter—there is a definite advantage, from the operating standpoint, in placing all major equipment in one large room.

This ties in closely with the general adoption, in recent years, of centralized automatic control. It is now practicable and desirable to divide the large station into complete operating units, consisting of one or more turbines and the boilers and auxiliaries that serve them. With available control equipment one man can control the operation of the entire unit from a control board centrally located.

By removing the wall between turbine room and boiler room, the control operator at his station can see all the major equipment for which he is responsible and the man on the floor can do a better job. This arrangement insures co-ordination between steam production and use. It centralizes the responsibility for the complete operating unit, and leaves the chief operating engineer free from routine duties to devote his entire time to the general problems of station management.

Clearly, this practice is sound, and its field of application will expand.

Maintenance—A Cure for Insulation Troubles

PROOF that insulation is a vulnerable spot in electrical machines is found in an analysis of failures in generators and motors reported by the Vulcan Boiler & General Insurance Company, Ltd. Investigation showed that in direct-current motors nearly sixty per cent of the failures were in the armatures, and these accounted for over seventy per cent of the repair costs. In direct-current generators these values are over eighty and ninety per cent, respectively. In alternating-current, slip-ring motors over sixty-one per cent of the breakdowns were in the rotor and stator windings, and represented eighty-five per cent of the repair costs. Nearly seventy per cent of the failures in squirrel-cage motors were in the stator winding.

These figures indicate that the winding insulation offers the greatest possibilities for improving reliability. This does not necessarily mean better quality of insulation or factory workmanship. The best insulation available is easily destroyed by oil, by vibration, or by overloading. An investigation by the Association of Iron and Steel Electrical Engineers showed that from forty to ninety per cent of winding failures resulted from oil getting on the insulation. Prevention of this difficulty lies in the selection of motors with bearings designed to keep the dirt out of, and the oil in, the bearing.

Electrical machinery winding troubles cannot be eliminated entirely, but proper inspection and maintenance procedure will prevent small defects from developing into serious faults. This is shown in the insurance report, where it is pointed out that increased attention to periodic inspection and testing of transformer oil last year greatly reduced failures.

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POWER *Stands for . .*

1. **Making Power When It Should Be Made**
2. **Buying Power When It Should Be Bought**
3. **Cheaper Power Through Modern Equipment**
4. **Easier Financing of Equipment Purchases**
5. **Better Use of Byproduct Heat and Power**
6. **Operating Methods That Save Money**
7. **Less Waste in Transmission and Application**
8. **Prevention of Smoke, Within Reason**

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THE WORLD'S BIGGEST GAS ENGINES

To a 21,600-kw. gas-electric power plant the South Chicago Works of the Illinois Steel Company has added two 6,600-kw. units operating on blast-furnace gas. Each engine required forty 50-ton cars to transport it

THE two 6,600-kw. gas engines recently installed in the South Chicago Works of the Illinois Steel Company are notable as being the largest ever built. The engines are of the four-stroke-cycle, double-acting, twin-tandem type, each having four 60x64-in. cylinders, and operate at 83⅓ r.p.m., driving 6,000-6,600-kw. generators.

In working out the design it was necessary to give special consideration to certain factors because of the large size of the machines. The thrust on the piston at the point of greatest gas pressure, following explosion, is 880,000 lb. The total length of connected engine parts under working stresses is about 60 ft., so that the elongation of this structure by temperature increase and owing to the elasticity of cast iron is considerable.

Provision is made for lateral expansion and elastic stretch along the center line of each side of the engine by anchoring the main frames to the foundation and by supporting the tie pieces and the tail guides on cast-iron columns designed to flex in the direction of elongation and contraction produced by the power impulses. The cylinders are supported between the frames and tie pieces and tail guides, the supporting columns being required to carry only the deadweight of the engine parts.

The frame, which is of heavy box type, is made in two sections to facilitate transportation and handling. The

Fig. 1—The main crosshead, which weighs 10 tons

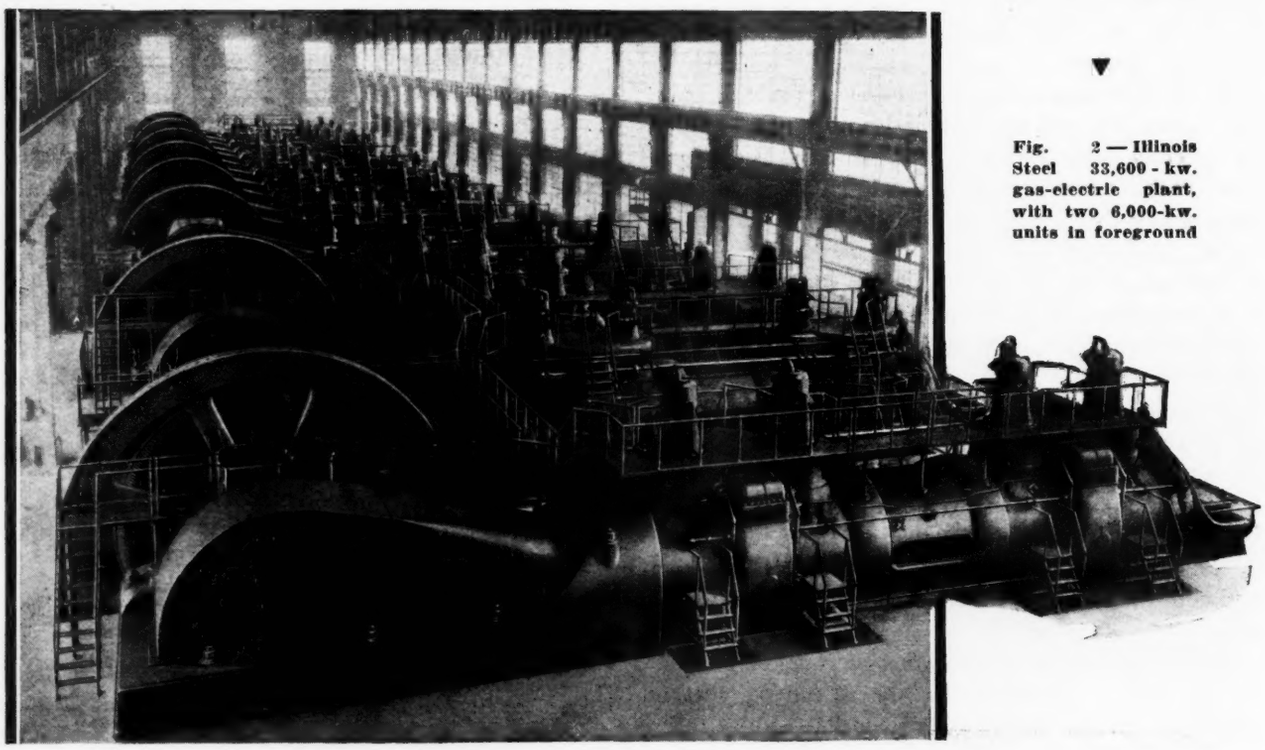


Fig. 2 — Illinois Steel 33,600-kw. gas-electric plant, with two 6,000-kw. units in foreground

joint between the two sections is in a vertical plane passing through the center line of the cylinders. This construction retains the most important features of a one-piece frame, as the larger section carries the main bearing for the crankshaft and extends to the front cylinder direct. The two sections of the frame are joined together by turned bolts fitted into reamed holes. The crosshead slide is a separate casting bolted into the frame.

In general design, the main bearings, cranks, crankpins, crosshead pins and connecting rod follow the company's standard construction. The bottom shell of the main bearing has a spherical seat in the bottom of the jaws in the frame, which has been found entirely satisfactory even with the tremendous weight carried on these spherical seats. The bottom shells of the main bearings are water cooled, and circulation of the cooling water is provided by a brass tube embedded in the babbitt metal and shaped with return bends to provide efficient cooling for the whole bearing surface of the shell.

Each crank and crankpin is of open-hearth cast steel, and the parts are cast integral. These castings were given an unusually thorough annealing. The crankpin is made undersize in diameter and is fitted with a high-carbon

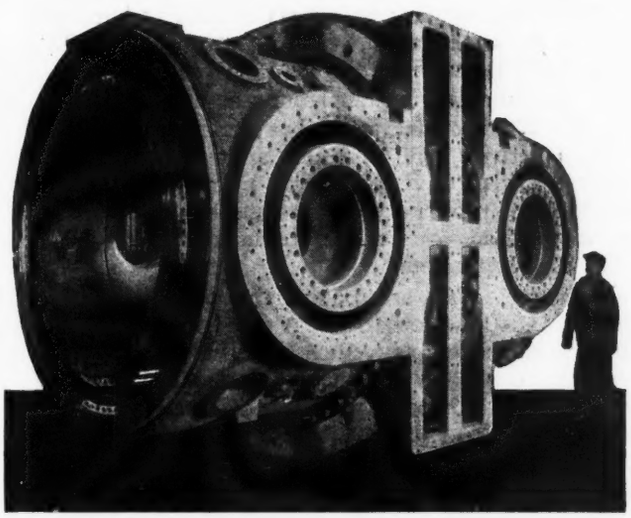


Fig. 3—One of the 60x64-in. cylinders

forged-steel sleeve which provides an excellent wear-resistant journal for the connecting rod boxes. The intermediate and tail-rod crossheads have slipper type shoes connected to the crosshead by a rocker construction that insures uniform bearing of the crosshead shoes on the surface of the slide throughout its length.

Construction of a water-jacketed cylinder of this large size required special provisions for relieving strains. The cylinders are sectionalized to reduce casting shrinkage strains to a minimum. Each cylinder is completely assembled, finished bored, and shipped as a unit without valve gear parts or head. The cylinder proper is cast in two cylindrical halves bolted together through heavy flanges and aligned by a recessed fit. The inner and outer walls of the cylinder barrel are not joined at the ends of the cylinder in casting, the open ends of the water jacket space being closed with copper plates that serve as expansion joints.

The design provides for transmitting working stresses through the outer wall of the cylinder (which is about the same diameter as the barrel of the tie piece) and through the cylindrical end of the frame to which the front cylinder is attached, thus making a continuous rigid cylindrical construction extending from the frame through the two tandem cylinders and tie piece. The inner wall of the cylinder is subjected to the working pressure of the gases only, and is connected with the outer wall in such a manner that the unequal expansion resulting from the great difference in temperature does not strain the casting beyond allowable limits. The working bore of the cylinder is fitted with a renewable, one-piece, hard cast-iron liner.

Gas inlet nozzles and exhaust outlet nozzles are cast integral with the inner wall of the cylinder barrel, but separate from the outer wall, and are thus free to move with the former without restraint by the latter, water jacket spaces around the nozzles being closed with copper-plate expansion joints. The distributing chamber at the top of the cylinder and gas and air belts leading from the bottom of the cylinder to the distributing chamber are cast separately and clamped about the cylinder against circular shouldered fits. The water jacket space around the cylinder barrel is necessarily large and is designed with considerable depth. To insure proper circulation of the cooling water, diffusers are provided to divert it to all parts of the water jacket space and thus insure uniform cooling.

Compressed air at 200 lb. gage is piped to each air starting valve, and the supply is under control of a single throttle valve for each pair of tandem cylinders. Notwithstanding the large masses to be accelerated, it requires less than two minutes to start one of the units, bring it up to speed, synchronize it, and have it carrying its share of the station load.

Long experience with a large number of engines has shown that the Allis-Chalmers "stratification" valve gear is well adapted to blast-furnace gas. By stratifying the gas and air and throttling both when entering the annular mixing chamber to give a high velocity, a thorough mixture of gas and air is obtained before entering the cylin-

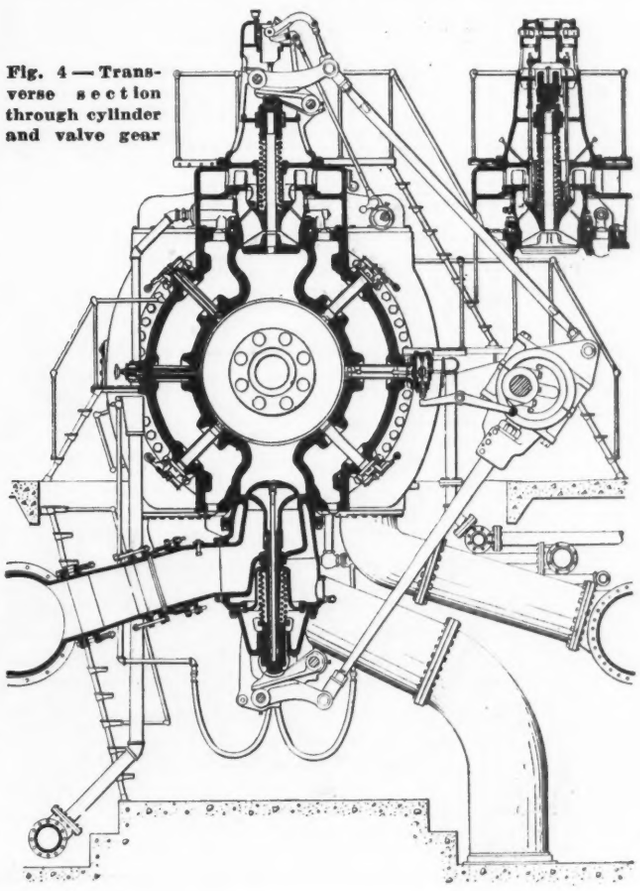


Fig. 4 — Transverse section through cylinder and valve gear

Physical Dimensions and Weights of Gas-Electric Units

Gas Engines

Builder	Allis-Chalmers Mfg. Co.
Number of units	2
Normal load rating	6,000 kw., 10,000 b.hp.
Maximum load rating	6,600 kw., 11,000 b.hp.
Speed, r.p.m.	83⅓
Kind of fuel gas	Blast furnace
Heat value of gas, B.t.u. per cu.ft.	92
Floor space occupied, one unit, ft.	85x46
Height top i.v. chamber above floor, ft.	16
Number of cylinders	4
Size of cylinders, in.	60x64
Crankpins, in.	30x27
Crosshead pins, in.	21x26
Main bearings, in.	40x64
Diam. of shaft at center, in.	43
Flywheel, cast-steel, segmental, diam. in ft.	26
Cooling water per unit, gal. per hr.	100,000
Gas per unit, normal load, cu.ft. per hr.	850,000
B.t.u. per kw.hr., normal rated load	13,000
Thermal efficiency, net over-all, per cent	26.25

Weights of Parts in Pounds

Complete engine with wheel	3,500,000
Frame, in 2 sections	357,500
Cylinder without valves or gear	168,000
Connecting rod	30,500
Shaft	128,700
Shaft with cranks and wheel hub	265,000
Main crosshead	20,150
Piston	9,000
Piston rod	17,300
Flywheel	185,000

Generators

Builder	Allis-Chalmers Mfg. Co.
Type	Engine
Rating at 85 per cent power factor, 24 hr. continuous, kw.	6,000
Overload rating at 85 per cent power factor, 2 hr., kw.	6,600
Current	25-cycle, 3-phase, 2,300-volt
Efficiency at full load, per cent	97
Weight of rotor, lb.	130,000
Weight of complete generator, lb.	265,000

der. This thorough mixing produces a high mean effective pressure and great overload capacity with high thermal efficiency. The quantity of gas and air per charge is varied, by governor control, to meet changes in load.

The mechanism for varying the timing and lift of the gas inlet valves on an engine of this size requires for its operation more power than can be supplied directly from the governor. Therefore, a hydraulic relay, using an oil medium, controls the timing of the inlet valve, the governor operating the pilot valve of the relay only.

Igniters are of the make-and-break type, mechanically operated. There are four igniters at each cylinder end, equally spaced around the circumference. All igniters on each pair of tandem cylinders are under the same control, and they may be simultaneously retarded or advanced by a single handwheel. Direct current at 110 volts, with lamp resistance, is used for ignition.

Although the units are required frequently to carry peak loads 20 per cent in excess of normal rating, "flooding" does not occur at any load, because of the throttled admission of the gas. Efficient scavenging is an important factor in the large overload capacity and high fuel economy of these units.

Economy tests have not yet been made, but general performance, together with tests of similar but smaller units in the same station, indicate that a figure of 13,000 B.t.u. per kilowatt-hour will be readily attained.

In the accompanying tabulation are given the sizes and weights of important parts, but the magnitude of the engines perhaps will be better appreciated when it is understood that each unit weighs nearly 2,000 tons, and required forty 50-ton cars to transport it, and that at maximum load one engine consumes about 1,000,000 cu.ft. of gas per hour.

In the same plant are six similar but smaller machines, each of 3,600-kw. capacity. A third 6,000-kw. unit is under construction, as well as six 4,500-hp. gas blowing engines. Upon the completion of this installation, the Illinois Steel Company will have 77 gas engine units, totaling 270,000 hp.; and in all of the plants of the United States Steel Corporation there will be 104 gas engine units, totaling 350,000 horsepower.

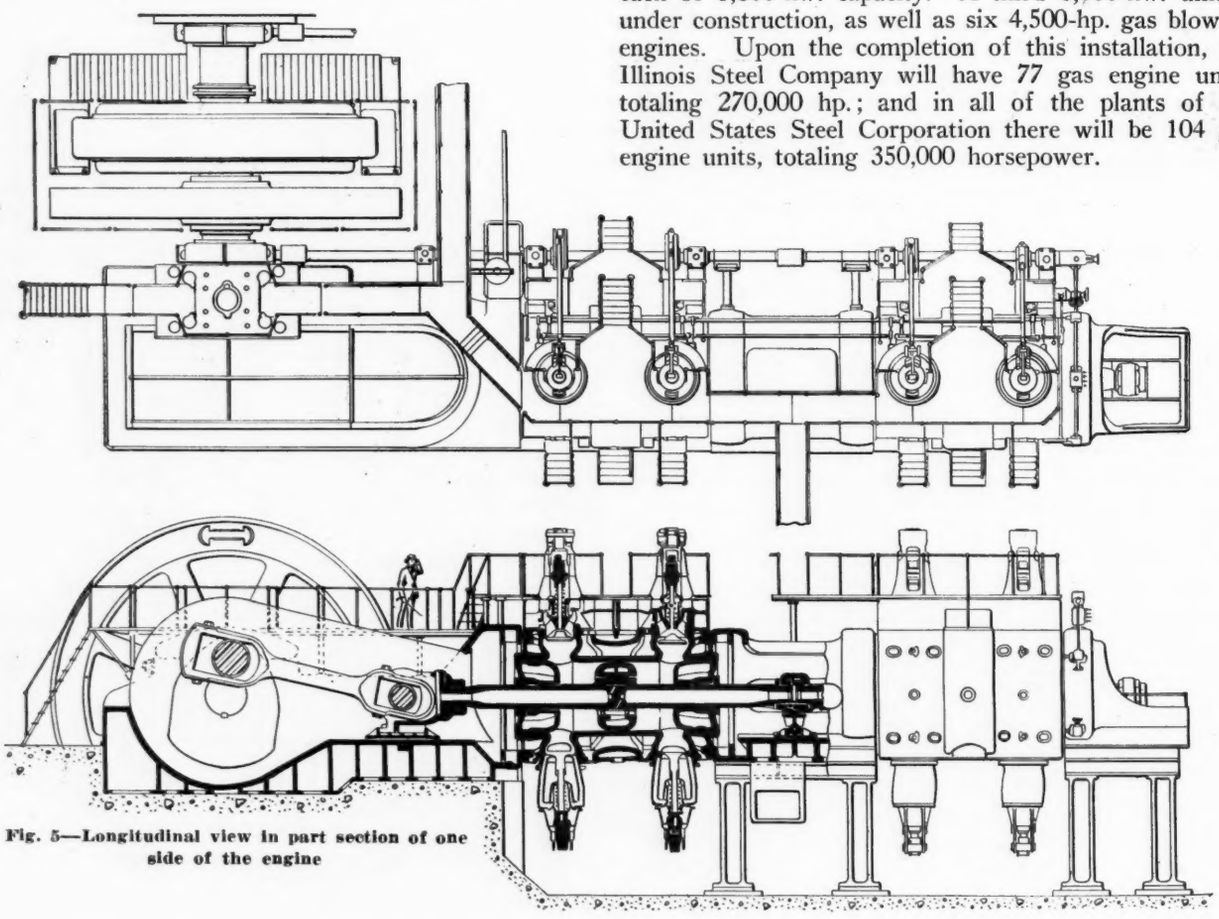
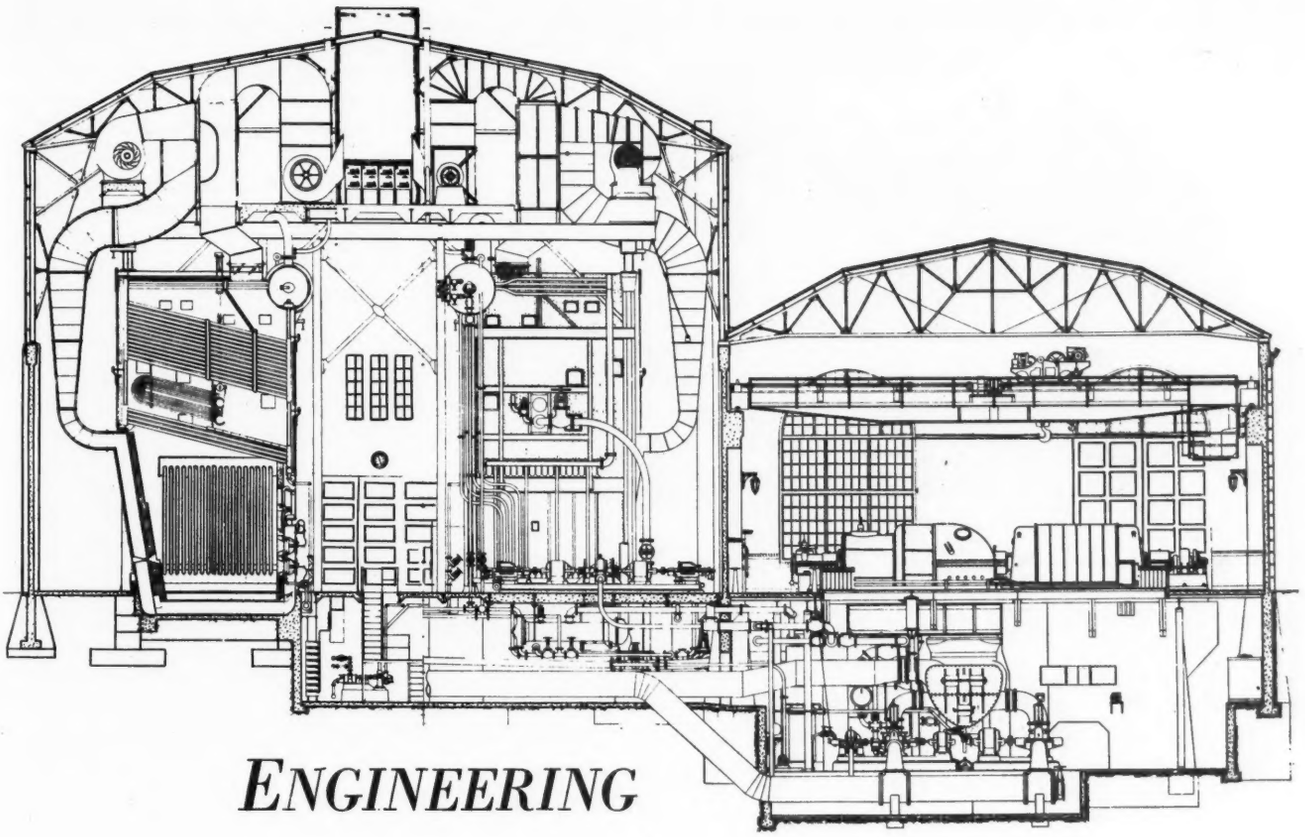


Fig. 5—Longitudinal view in part section of one side of the engine



ENGINEERING PROGRESS in

Pasadena Municipal Plant

By L. M. JORDAN

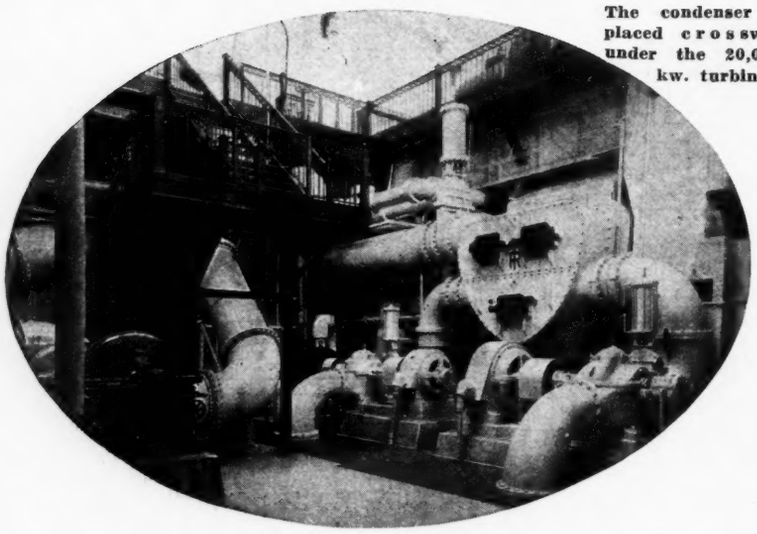
THE MUNICIPAL light plant of Pasadena, Calif., typifies the advance made in power plant engineering during the past twenty years. Increased demand has required the addition of new units from time to time, each of which has been representative of its day, as the tabulation on Page 741 shows.

In spite of the advance in design complications of such equipment and the betterment of efficiency, the cost of each successive unit has decreased. Units 6 and 7 of this plant give the most interesting study of small modern central station equipment, being the last machines to be installed.

Unit 6 was installed at about the time that boiler pressures and temperatures began to attain higher values. In selecting the unit it was decided that 250 lb. pressure and 600 deg. should be adopted. At that time extraction feed-water heating had seen but little development and so was not included, and for the same reason air preheaters, motor-driven auxiliaries, draft fans and water walls were absent. The heat balance and feed-water heating was accomplished by varying the proportional load on the turbine of the dually driven steam-electric circulating pump. This unit was installed in 1924. No great efficiencies resulted, and during normal-load periods the heat consumption ranged between 25,000 and 26,000 B.t.u. per kilowatt-hour, equivalent to 240 to 250 kw.-hr. per barrel of oil.

By the time No. 7 unit was designed radical changes had taken place in power plant equipment. A 725-deg. throttle temperature with 400 lb. working pressure was adopted for this unit. The 400-lb. turbine cost no more than a 250-lb. unit, and by sufficiently high steam pressures and temperatures at three bleed taps it was possible to practice extraction feed-water heating. The pressures and temperatures for these three bleed taps are: for the low-pressure tap, 9 lb. abs. and 193 deg. F.; for the intermediate tap, 37 lb. abs. and 325 deg. F.; and for the high-pressure tap, 140 lb. abs. and 505 deg. F. A 6 per cent increase in plant efficiency has been achieved by the use of extraction feed-water heating under full-load conditions as compared with No. 6 unit, upon which no extraction heating is practiced.

The city has a typical lighting load curve that reaches about 15,000 kw. in the early evening and after a comparatively short period falls rapidly. In view of this fact the specifications for the No. 7 turbine emphasized the desire for a turbine-generator with high overload capacity for a period of two hours. It was considered



The condenser is placed crosswise under the 20,000-kw. turbine

that a generator capable of carrying this high peak load for two hours would serve as well as one built to carry such a load continuously. As a result, a 20,000-kw., 60-cycle unit was furnished. This would give a nominal rating of such a unit in that city, where the frequency is 50 cycles, of 83 per cent of 20,000 or 16,600 kw. Such a load has been carried on the unit for two hours with no damage from excess heating.

When No. 6 unit was installed it was equipped with an open-type deäerating feed-water heater with a capacity of 300,000 lb. per hour when raising the water temperature from 100 to 210 deg. This was sufficient for the boilers feeding both Units 6 and 7, and as the intermediate-bleed tap of No. 7 has a higher-than-atmospheric pressure for all loads in excess of 5,500 kw., the heater of Unit 6 is used for both. This avoided the cost of a deäerator and an intermediate-stage heater; in addition, no evaporator condenser is necessary, because the distilled vapor is piped direct to the open heater, where it is condensed in heating the condensate from the low-pressure heater. Since the open heater was designed for broad fluctuations in the flow of condensate to be heated, a condensate surge tank is not necessary and the feed pumps for both units are supplied from the open heater.

The low-pressure heater of No. 7 is of the closed shell-and-tube type, and the condensate is pumped through it into the open heater by the hot-well pump, the drips being piped to the main condenser hot well. The feed pumps of the boiler are below the open heater and operate with a positive suction head of approximately 12 ft. These pumps force the water through the high-pressure feed-water heater, which is also of the closed shell-and-tube type.

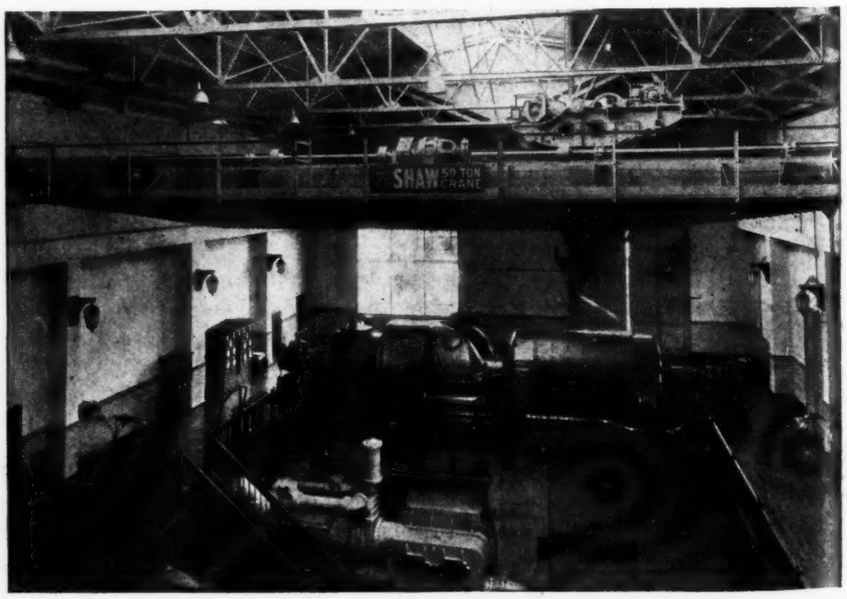
A final feed temperature of 325 to 350 deg. F. is obtained by this system of feeding, and only one manually operated valve is necessary, the throttle valve, which, in accordance with the load, controls the flow of steam to the open heater from either the intermediate- or high-pressure bleed tap. The feed water is kept at 210 deg. F. by maintaining a positive steam pressure of 2 or 3 in. of water in the open heater; the dissolved oxygen with some vapor is expelled through the vent condenser, where the vapor is condensed and returned to the heater, the air passing to the atmosphere.

The condenser of No. 6 turbine is of the single-pass type, with 14,250 sq.ft. of surface, and is supplied with cooling water by a single dually driven pump with a capacity of 21,000 gal. per minute, while that of No. 7 is of the two-pass type, with 16,250 sq.ft. of surface, two pumps being used to supply it. One of the pumps is driven dually by a motor and a turbine, and has a capacity of 6,500-gal. per minute, and the other, which has a capacity of 12,500 gal. per minute, is motor driven. Both condensers were built to operate under identical water and vacuum conditions.

Changing from a single, dually driven pump for No. 6 unit to two for No. 7 was done for reliability and flexibility, and to conserve power during light loads. The turbine was installed only for emergency use and is direct connected by a reduction gear. The vacuum in the main condenser can be maintained within an inch of full by overspeeding this turbine during an emergency.

In selecting boilers for the plant, straight-tube, cross-drum boilers with serpentine headers were chosen, because only one drum has to be kept tight at high pressure, and only one form of spare tube was required. Then, too, a more favorable combustion space could be had for a certain height of setting for oil burning without oil fuel impinging on the tubes, and a lower refractory wall could be used than would be possible with the bent-tube type. Additional advantages were

View of turbine room, showing No. 7 unit. In front of the machine is the well above the condenser equipment



Principal Equipment Installed With Pasadena No. 7 Turbine

Boiler Equipment

Boilers, two, sinuous-header cross-drum, 450-lb. pressure 15,260 sq.ft. each, Walsh & Weidner type.....Combustion Engineering Corp.
Superheaters, 5-pass, bare-tube, for 724 deg. total temperature .....Foster Wheeler Corp.
Furnace, two, 7,000 cu.ft., with water-cooled side walls, and air-cooled rear wall, decking and front wall....Combustion Engineering Corp.
Soot Blowers .....None
Air preheaters, two-plate type, to raise temperature to 350 deg. F. .....Green Fuel Economizer Co.
Feed-water regulators .....None
Water columns .....Reliance Gauge Column Co.
Safety valves .....Consolidated Ashcroft, Hancock Co.
Blow-off valves .....Yarnall-Waring Co.
Non-return Valves .....Edward Valve & Mfg. Co.

Fuel Equipment

Oil Burners, combination gas-oil, 12 per boiler.....Peabody Engineering Corp.
Fuel oil pumps, one 35 g.p.m. and one 75 g.p.m., 200 lb. discharge pressure, screw type.....Quimby Pump Co.
All Strainers, two twin-screen type..C. F. Braun Co., and Coen Co.
Stack and breeching, steel.....Western Pipe & Steel Co.

Turbine Equipment

Turbine generator, one 20,000-kw., 50-cycle, 2,300-volt, 3-phase, 20,000-kw. .....Allis-Chalmers Mfg. Co.
Condenser, one, horizontal, 2-pass 16,250 sq.ft. surface..... Ingersoll-Rand Co.
Circulating pumps, motor-driven Cameron centrifugals, one, 118-in. 980-r.p.m., 12,600-gp.m., 60-ft. head, and one, 14-in., 6,300-g.p.m., 980-r.p.m. .....Ingersoll-Rand Co.
Condensate pumps, two, single-stage Cameron, 400 g.p.m. 125-ft. head, 1,500-r.p.m.; one motor-driven and one turbine driven .....Ingersoll-Rand Co.

Feed-Water Treating and Heating

Water softener, 300-g.p.m., zeolite system with filters..Permutit Co.
Evaporator, one, 75,000 lb. per hour single-effect..... Griscom-Russell Co.
Heater, 300,000 lb. per hour open type.....Cochrane Corp.
Vapor condenser .....Cochrane Corp.
Feed pumps, two, 5-stage, single-suction, 500-g.p.m., 600-lb. head, Cameron centrifugal, dual-driven by motor and Sturtevant turbine .....Ingersoll-Rand Co.
Bleeder heater, one 2-pass type, to heat water from 120 to 180 deg. F. .....Griscom-Russell Co.
Water storage tank, 25,000-gal.....Western Pipe & Steel Co.
Air injector, one, double steam air ejector, each half containing six primary and three secondary steam jets..Ingersoll Rand Co.

Piping and Valves

High-pressure piping, with Sargol joints...Midwest Piping & Supply Co.
High pressure, gate valves, 600-lb.....Crane Co.
Check valves .....Lunkenheimer Co.
Reducing valves .....Leslie Co.
Standard valves .....Crane Co., Chapman Valve & Mfg. Co. and Lunkenheimer Co.
Pipe covering .....Johns-Manville Corp. and General Insulating & Mfg. Co.

Instruments

Pressure gages .....Consolidated Ashcraft, Hancock Co.
Draft gages, two multipointer.....Bailey Meter Co.
Boiler water level recorders (Westcott).....American Meter Co.
Feed-water flow meters, two orifice type.....American Meter Co.
Condensate meters, one, weir type .....Cochrane Corp.
CO_2 meters, two, recording manometers .....Bristol Co.
Recording gage .....Bristol Co.
Master gage, one.....Ashton Valve Co.
Recording thermometers .....Bristol Co., Bailey Meter Co.
Mercury column vacuum gages.....Taylor Instrument Co's
Barometer .....Taylor Instrument Co's

Miscellaneous

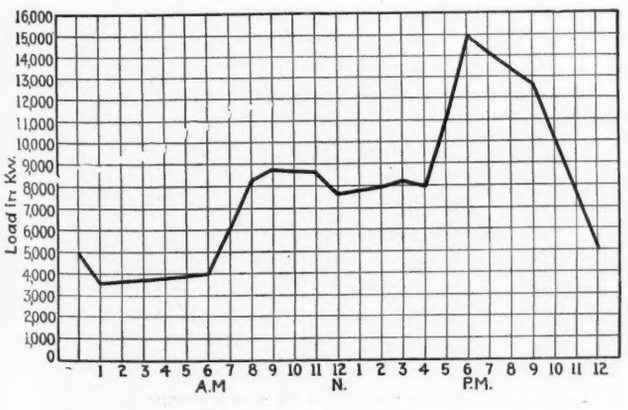
Overhead traveling crane, 50-ton..Shaw Crane-Putnam Machine Co.
Miscellaneous steel supporting structure....Llewellyn Iron Works
Sump pumps, two, vertical..Yeomans Bros Co., American Pump Co.

that the water-level readings would be more reliable and there would be less danger of water being pulled over into the turbine in case of a sudden increase in load. The cost was no greater than that of the bent-tube, multi-drum type.

A furnace of 7,000 cu.ft. combustion space was provided, calling for the heat release of approximately 35,000 B.t.u. per cubic foot per hour at 325 per cent maximum rating. Bare-tube water screens embedded in the refractory were installed to cool the walls. An incline of 2 in. per foot was made in the rear wall, which is cooled by combustion air descending along this wall on the way to the burner windbox.

Excellent results have been obtained with this construction and the walls were found to be in perfect condition after 5,000 hr. of service. Thermocouples located at points of highest temperature in the walls indicated a maximum temperature of but 2,100 deg. F. at 325 per cent of rating while burning oil.

By locating both forced- and induced-draft fans on a deck over the boilers, short connections between the boiler outlet, induced fans, heater and stack could be used. Since the feed water is sufficiently heated by extraction steam, and the stack gases are reduced to 300 deg. F. by the air preheaters, no economizers are employed.



Pasadena load curve

Another feature of the finished plant worth noticing is the convenience of controls, which makes the operation of the plant easily cared for by only three men to the shift. All instruments in the boiler room are mounted on a single panel, thus enabling the fireman to exercise full control over all phases of boiler operation and read all changes of the indicators as they occur. A series of hand wheel floor stands in the turbine room are readily accessible to the turbine tender, requiring him to take only two or three steps from his position at the instrument to reach any one of them. The large circulating valves are operated by hydraulic cylinders, whose controls are also mounted on this operating panel. The operator's position is on the switchboard gallery overlooking the turbine room, and five different stations in the plant are interconnected by a telephone system. The fact that the plant is operated by only three men to the shift is sufficient to draw special attention to the control features.

TABLE OF COMPARATIVE DATA OF PRIME MOVERS OF THE PASADENA POWER PLANT

Unit No.	Installed	Voltage	Capacity, Kw.	Floor Area Occupied by Units, Sq.Ft. per Kw. Cap.	Condenser Surface, Sq.Ft. per Kw. Cap.	— Steam — Pressure, Lb. Gage	Temp. Deg. F.	B.t.u. per Kw.-Hr.
1	1907	2,400	200	1.32	3.62	200	480	50,000
2	1908	2,400	240	1.35	4.58	200	480	46,300
3	1909	2,400	707	1.28	3.40	200	480	41,700
4	1911	2,400	1,100	.16	....	200	480	39,100
5	....	2,400	3,000	.10	....	200	480	34,700
6	1924	2,400	10,000	.06	1.42	250	600	26,000
7	1929	11,000	15,000	.05	1.08	400	725	19,200

What's What in
FLEXIBLE COUPLINGS—II

In the April 29 number pin-type flexible couplings were described. In this article several other types are taken up. A third article will cover the remaining types and will be followed by a story on coupling applications

By F. A. ANNETT
Associate Editor of POWER

SEVERAL couplings have been developed on the principle of the jaw clutch. Two such couplings are shown in Figs. 19 and 20. The multi-jaw type, Fig. 19, is made of steel and operates on metal-to-metal contact. In the three-jaw type, Fig. 20, a non-metallic piece inserted on one side of each jaw acts as a cushion between the jaws to absorb shocks and vibration and to prevent metal-to-metal contact. These types are made in small sizes only. Three-jaw solid metallic couplings are made in sizes up to 75 hp. at 300 revolutions per minute.

Fig. 21 is a modification of a jaw clutch that has a separate flexible member. The two flanges are made of semi-steel casting with three projecting lugs on each, and the flexible member is a star-shaped rubber disk. On the bearing surfaces of the lugs the slope is such that the load on the disk is in compression over a large surface. A coupling that consists of two jaw flanges with a cross leather member between them is shown in Fig. 22. The coupling in Fig. 23 has three jaws on each half of the coupling, with a round rubber member between them. The rubber gives added resiliency to the coupling to absorb shocks and vibration. The type in Fig. 24 has two flanges with lugs cast integral. The lugs fit into a leather disk that provides flexibility in every direction. The couplings in Figs. 21 to 24 not only provide flexibility, but they also insulate the driving shaft from the driven.

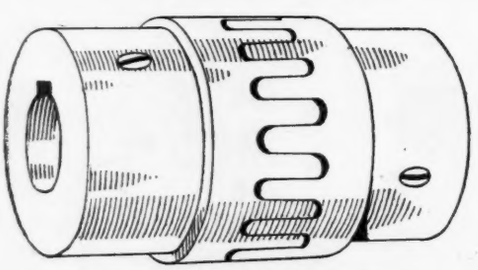


Fig. 19—Multiple-jaw coupling

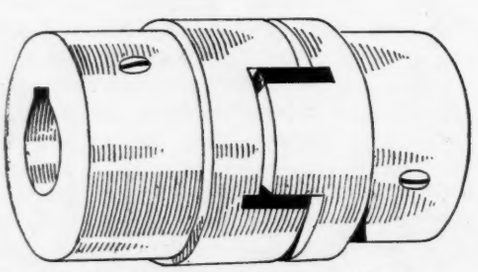


Fig. 20—Jaw coupling with non-metallic insert

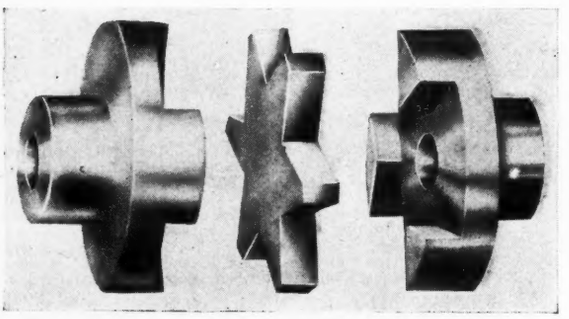


Fig. 21—Three-jaw coupling with star shaped flexible member

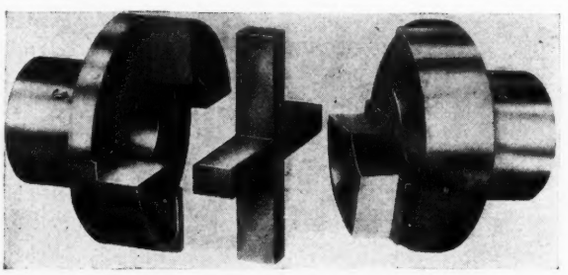


Fig. 22—Two-jaw coupling with leather-cross flexible member

The coupling in Fig. 25 consists of two heavy cast-iron hub disks, each having two steel studs. Each stud carries a square steel block. The latter engage with machined slots in an intermediate steel disk. The blocks are provided with spring oilers and the coupling is designed for heavy slow-speed shafts.

An insulated coupling for loads up to 30 hp. at 100 r.p.m., Fig. 26, has lugs cast integral with the inner surface of the flanges. The lugs fit into slots in the outer periphery of a center high-grade English sole-leather disk. This disk is held in place on the flange lugs by small pins having disk heads that extend out over the edges of the slots. The disk-head pins are held in place by countersunk set-screws that are threaded into the coupling's flanges.

Instead of the hubs of the coupling meshing as in some of the types previously described, a floating member is used between them, as in Fig. 27. The floating centerpiece is made of steel and interlocks with the cast-iron hubs. Grooves in the hubs are accurately machined, and the center disk tongues are finished for a sliding fit.

This coupling will take care of parallel and angular misalignment and is suited to applications on heavy slow-speed drives.

A rather novel design is shown in Fig. 28. It is a modification of the type in Fig. 27: A center member is constrained to slide across the face of one coupling flange on a line passing through the center and at the same time is free to slide across the face of the second flange in a direction at right angles to the first. The floating member is a square, hollow casting with a hole in the center to provide clearance for the shaft ends. On the edges of the floating member are fastened non-metallic bearing strips, such as are used in the manufacture of non-metallic gears. These strips can be replaced without disturbing the coupling or the shaft connections. The floating member is hollow and is filled with grease, which passes to the surface of the wearing strips through channels furnished with wicks. In operation, centrifugal force assists to provide proper lubrication. By means of an ordinary grease gun the center member can be filled through any one of the holes for the bearing-strip retaining screws.

The floating member of the coupling in Fig. 29 is a cylindrical block with four pins at right angles to each other. On each pin is placed a metal block that fits in between lugs cast integral with the hub flanges. From the construction, it is evident that the hubs are free to move with respect to each other and to compensate for any misalignment.

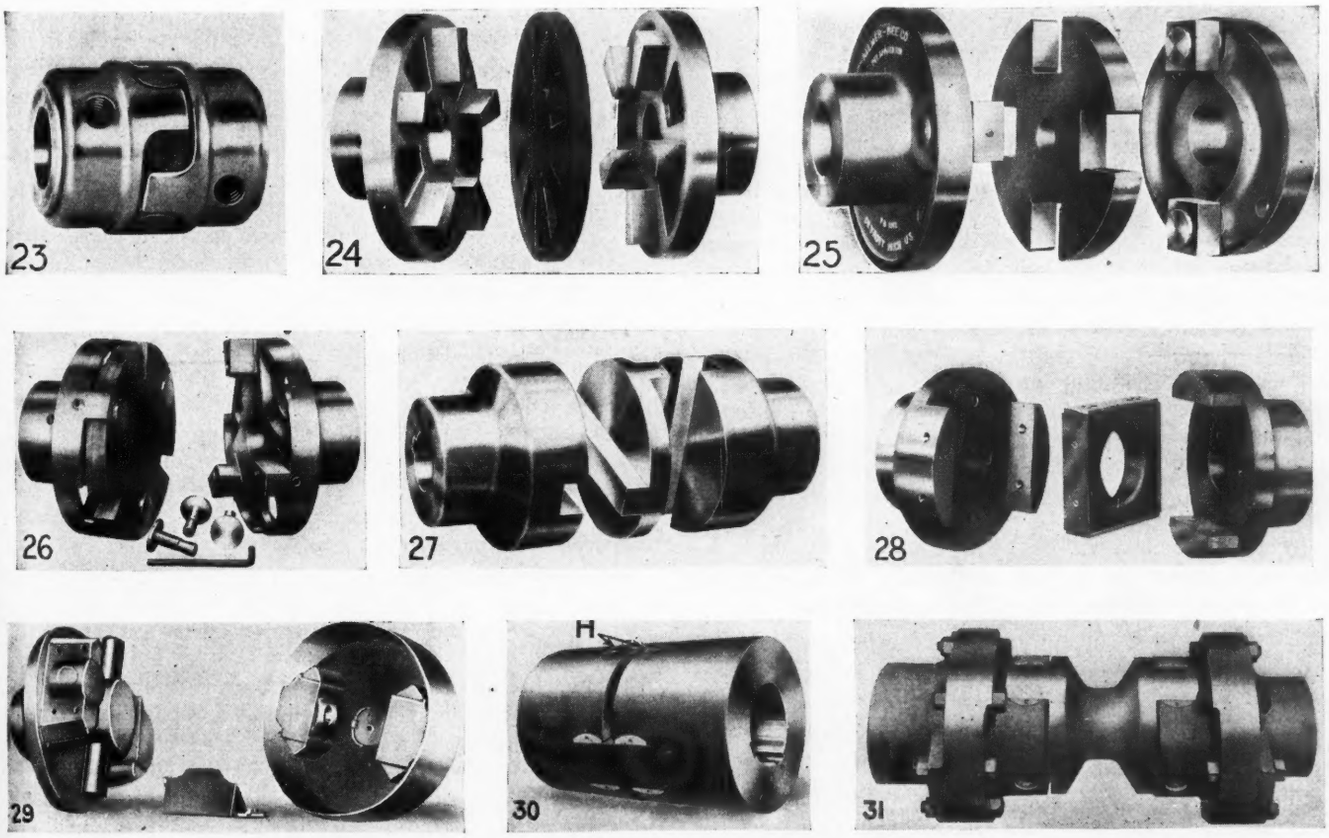
Fig. 30 shows a type consisting of two female half couplings that have machined cylindrical seats in which are placed bronze bearing segments. The halves of the coupling are connected through these bearing segments by a central flat member. The latter is held central by hardened steel pins inserted in the holes *H*, and are retained in place by plugs. Removing the plugs releases the pins, and the coupling is easily taken apart. The coupling is inclosed in an oil case filled with a lubricant. Where large amounts of misalignment are to be taken care of or it is difficult to keep the shaft in line a double-type coupling is used, Fig. 31. These couplings are built in sizes up to the largest capacities.

A leather floating member is used in the coupling in Fig. 32. Lugs are cemented and riveted or bolted on each side of a heavy leather disk. The lugs fit into openings in the hub flanges. This coupling acts as an insulator between the two shafts and is built in any size up to 500 hp. at 100 revolutions per minute.

A leather cross forms the flexible member of the coupling shown in Fig. 33. In the rims of the hubs

MANUFACTURERS OF THE COUPLINGS SHOWN IN THE FIGURES

Figs. 19 and 20.....Boston Gear Works, Norfolk Downs, Mass.
Fig. 21.....W. A. Jones Foundry & Machine Co., Chicago, Ill.
Fig. 22.....Chas. Bond Co., Philadelphia, Pa.
Fig. 23.....Lovejoy Tool Works, Chicago, Ill.
Fig. 24.....T. B. Wood's Sons Co., Chambersburg, Pa.
Fig. 25.....Palmer-Bee Co., Detroit, Mich.
Fig. 26.....Charles Bond Co., Philadelphia, Pa.
Fig. 27.....D. O. James Mfg. Co., Chicago, Ill.; W. A. Jones Foundry & Machine Co., Chicago, Ill.; T. B. Wood's Sons Co., Chambersburg, Pa.; Philadelphia Gear Works, Philadelphia, Pa.; Webster-Weller Mfg. Co., Chicago, Ill.
Fig. 28.....American Flexible Coupling Co., Erie, Pa.
Fig. 29.....A. & F. Brown Co., Elizabethport, N. J.
Figs. 30 and 31.....Mesta Machine Co., Pittsburgh, Pa.
Figs. 32 to 34.....Charles Bond Co., Philadelphia, Pa.



FIGS. 23 TO 31—THESE COUPLINGS REPRESENT A VARIETY OF DESIGNS

Fig. 23—Rubber cylinders are the flexible member in this coupling. Fig. 24—The jaws on this coupling fit into a leather disk. Fig. 25—Square steel blocks on the pins on each half of this coupling fit into slots in a central steel disk. Fig. 26—Lugs cast integral with the flanges are held in slots in a leather disk by diskhead pins. Fig. 27—A floating steel center member interlocks with cast-iron hubs. Fig. 28—The floating member in this coupling is faced with non-metallic strips. Fig. 29—The floating member in this coupling is a cylindrical block with four pins placed at right angles to each other. Fig. 30—A central flat member in this coupling is carried in bronze bearing segments. Fig. 31—Double coupling of the type Fig. 30.

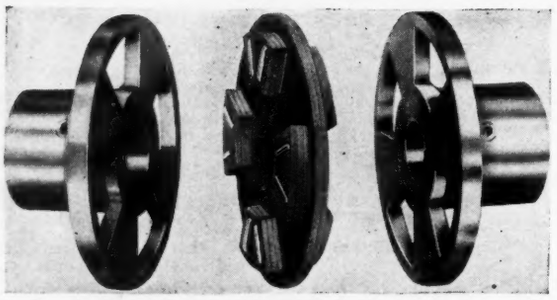


Fig. 32—Lugs on a leather disk fit into openings in the coupling flanges

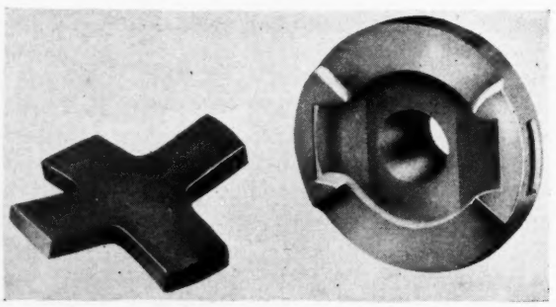


Fig. 33—A leather cross forms the connection between the two halves of this coupling

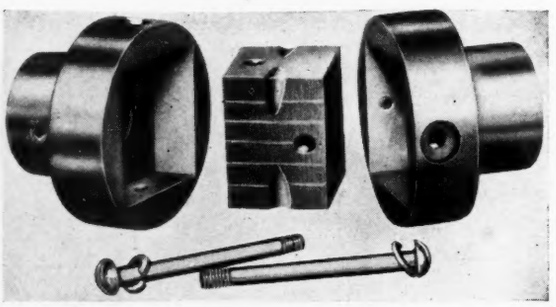


Fig. 34—A cube of leather forms the flexible member

are slots in which the ends of the cross rest. The slots in the two halves of the coupling are at right angles and allow a maximum freedom of movement. This coupling is made in small sizes only.

A cube of live cushioning leather forms the flexible member in the coupling in Fig. 34. The leather is of special tannage and treated to make it water- and oil-resistant. The flanges are die-cast and are recessed on their faces for the flexible cube. This coupling is built in sizes up to one horsepower at 100 revolutions per minute.

[The next article will deal with couplings in which the flexible member is a disk, and with types designed on the principle of external and internal gears.]

✦

BRIGHT ANNEALING WITH STEAM—An interesting application of superheated steam is described by C. L. Heisler, Jr., General Electric Company, in the March number of *Industrial Engineering*. Atmospheres of superheated steam are used in electric furnaces for bright annealing copper wire, to exclude air, and protect the material from oxidation. The work produced is as bright and clean as when put into the furnace. A very slight pressure is maintained in the furnace and is relieved by an inclined flapper valve.

Technical Journals and the Obsolescence Problem

By MARIN PHILLIPS
Electrical Superintendent
International Paper Company, Niagara Falls, N. Y.

THE TREND to modernization is commendable, but it should be followed only after a careful analysis and proper investigation to determine when a piece of equipment has reached the stage where it will not show a profit in its operation that will compare favorably with a new machine. When equipment has depreciated to where the loss in production and the cost of maintenance equals the cost of a new machine with its consequent maintenance during its expected life, it is ready for the scrap pile.

Sudden changes in industry and shifts in trade may catch us unaware in two ways. First, we may fail to heed the warning signal of obsolete equipment in time to prepare for its replacement, and allow it to cause disastrous results. Secondly, we may fall short in the interpretation of changing conditions. Machines that meet this year's requirements may be inadequate to manufacture next year's product. Then if the machines have not been revamped to meet the change demanded or equipped to manufacture a new product, the plant is inadequate and may fail to meet new competition. Machines may become obsolete through change in trade and yet be capable of many years of good service with a minimum amount of repairs. It is this type of obsolescence that is apt to prove the most fatal.

There are three types of machinery obsolescence. First, that brought about through business cycles and public demand, which only the best business executive can cope with to the best advantage. Secondly, there is obsolescence due to age, condition and expensive upkeep, which will tax the plant engineer's ingenuity to the utmost in deciding when a machine has served its useful life or is entering the stage where it will be a liability instead of an asset. Thirdly, there is the necessity of increasing production without an increase in building size.

Fortunately, the plant engineer has a more reliable source of information to base his decisions on than the business executive has in trying to meet next year's business demands. Today fact finding is a prerequisite to any undertaking. We are all seeking a yardstick by which to measure our decisions and an ouija board to tell us when to carry out the decision. The plant engineer's yardstick and ouija board are his cost records tempered by experience.

Modern plant engineering is moving forward at a rapid pace, and if one is to keep abreast of the times he must read extensively and study the other fellow's method of doing things. The technical journals are as indispensable to those who operate and requisition new machines as a kit of tools is to the mechanic doing a repair job.

The machines that were the last word in design and operation yesterday may be out of date today and supplanted by new ones tomorrow. So the big job for those in charge of plant maintenance is to determine when this stage is reached. The two best ways to accomplish this are knowing what the present machines are costing and doing, backed up by an acquaintance with new developments, as depicted in the advertising pages of technical journals and reinforced by the editorial pages.

THE STEAM ENGINE as the High-Pressure Prime Mover

By JOHN F. FERGUSON
Ferguson Engineers
Chicago

WHEN thinking of steam engines the average mind goes back to the ponderous horizontal, vertical, or combined horizontal and vertical, slow-speed engine of the older days, 1890 to 1900, when engines were the only steam prime movers. Most were of the open type, with piston speeds ranging from 400 to 750 ft. per minute and with a crank rotation as low as 60 r.p.m. in some of the larger belt-driving units. Engines for direct connection to electric generators were built in sizes up to nearly 10,000-kw. capacity at speeds down to 72 r.p.m.

In the last few years there has been a decided revival of the steam engine both in this country and in Europe. Many industries with process steam requirements are awakening to the possibilities in manufacturing their own power, and the engineering public is being educated to the higher efficiencies of the engine unit in back-pressure operation. While most of the engine units installed have been small, the demand is spreading to moderate and larger sizes.

▶▶▶

In a previous article in these columns the author pointed out the advantages of the steam engine for the higher ranges of steam pressure, particularly in back-pressure industrial applications. The present article gives his version as to what the coming prime mover will be like.—*Editor.*

▶▶▶

In many respects the characteristics of the steam engine are just the reverse of those of the steam turbine. In the engine unit the thermal stage efficiency increases with the pressure up to the critical pressure of 3,200 lb., whereas, over an equal range in expansion, the turbine efficiency becomes less with increased pressure. With the engine, the unit cost of construction is reduced and the mechanical efficiency raised with the pressure, owing to the smaller working parts. The engine unit is decidedly a high-pressure prime mover, and the turbine just as decidedly a low-pressure machine, each possessing particular characteristics to classify it for its specific field.

The range in speed permissible with steam engines of different sizes and capacities is such that the engine can be arranged conveniently for direct connection to many different classes of machinery or drives. For variable or adjustable speed drives, the engine maintains its efficiency closely over a wide range of operating speeds, has a high starting torque, is easy to regulate and can be made reversible.

With the advent of higher initial steam pressures and improved engine designs, contributing to much higher thermal, mechanical and electrical efficiencies, and to greatly reduced space, smaller foundations and lower first costs, the engine appears to be opening up a new era in industrial power development.

For industrial use the author foresees a new line of prime movers of the reciprocating type, adapted to moderate, high or extreme initial steam pressures, to different back pressures, or to a combination of back pressures, with steam bled from different stages of expansion. It will be possible to conveniently arrange these engines for complicated exhaust and bleeding pressures or efficiently alter them to meet new steam conditions.

Of the English type or modifications of it, these engines will be vertical inclosed machines using forced lubrication and high piston speeds.

They will be multiple-cylinder, compound-, triple-, quadruple- or quintuple-expansion, as determined by the initial and exhaust pressures. The small and moderate sizes will be arranged with two, three, four, and six cranks, and the larger engines with six, eight, twelve, and perhaps sixteen cranks.

Speeds will be determined by the class of service. For general industrial service and direct connection to electric generators, the speeds will be around 600 r.p.m. for 500-kw. units, 400 r.p.m. for 2,000-kw. machines, and from 300 down to 225 r.p.m. for sizes of 6,000 to 20,000 kw. Piston speeds will range from around 1,000 to 1,200 ft. per minute for the smaller stationary engines, from 1,200 to 1,600 ft. per minute for the moderate and larger sizes, and up to 2,000 ft. per minute for extremely high-speed service.

With the multiple-crank engine of high speed, one reciprocating part may be said to balance another, so that the engine with two, three, four, six or more cranks will be comparatively free from vibration. The greater the number of cranks, the better the balance and the lighter the foundations may be.

In an engine of this class, capable of operating under extreme steam pressures and temperatures, the valves should be balanced, have light weight and short travel, permitting the large port areas conducive to high-speed operation. These conditions can be met by the piston valve. Small engines generally will be single-valved, while in the medium and larger sizes each cylinder will have four valves to obtain the high efficiencies demanded. Poppet valves also may be used, for the piston-rod or valve-stem packing need not be exposed to the high pressures and temperatures.

As to internal lubrication, engines under high pressure have been operated successfully at temperatures ranging

up to 800 deg. F. Engines of certain types have been in operation for years at 350-lb. pressure without internal lubrication, and at higher pressures without any internal lubrication on the valves and pistons. An interesting case is the record of a marine engine using steam at 500-lb. initial pressure and at a temperature of 700 deg. F. without internal lubrication. With a slight amount of internal lubrication it is possible to design steam engines that will operate on steam temperatures of 1,000 deg. F., although little is to be gained in efficiency by going to this temperature even with the critical steam pressure.

Steam engines will not be limited by steam temperatures. At any rate, the working temperature limits will be as high as plant economy or operating efficiency will demand, or as high as it will be practical to provide steam generating units.

With steam engines, many are inclined to think that high speed means excessive wear of the working parts. This is not necessarily the case, in fact the results are just the reverse. As a proof of this, many high-speed English units of the multiple-crank type have been in daily service for years without even an adjustment of crank or crankshaft bearings. Better lubrication of the wearing surfaces is the reason for this superior working condition; partly on account of the oil being under pressure and partly because of the high speed, the reciprocating forces do not have time to work out the film of oil before the forces are reversed on a new film of oil. Hence the working metal surfaces do not wear each other, but operate constantly upon a film of oil, so that these bearings remain in excellent adjustment over long periods of operation. With gravity-feed lubrication in slow-speed engines, the lubrication conditions are less favorable.

The mechanical efficiency of the vertical high-speed, forced-lubrication, inclosed-type engine will be much higher than that of the horizontal slow-speed engine, on account of better lubrication and the lighter weight of the moving parts. Under favorable load conditions the mechanical efficiency should range from 92.5 to 95 per cent, as compared to 88 to 92 per cent for the slow-speed engine of like capacities, pressures, loads, and working conditions.

The combined mechanical and thermal efficiency ratio of the high-speed engine will vary only over a narrow range in the small unit of a few hundred kilowatts' capacity up to the extreme sizes ten to fifty times larger. The thermal efficiency ratio will vary with the initial steam pressure and the range and stage of expansion. The higher the initial pressure and the shorter the range in expansion the greater the ratio. In units of moderate capacities, 1,000 to 2,500 kw., the thermal efficiencies may run as high as 95 per cent in the higher pressure stages, down to perhaps a trifle under 90 per cent for the lower stages of expansion close to atmospheric exhaust pressure.

These engines will be used almost exclusively on back-pressure operations from a minimum of around 4 lb. abs. for water heating and low vacuum condensing service up to 250 lb. or over for some high-temperature manufacturing processes. Perhaps the greater usage will center between atmospheric and 25-lb. abs. exhaust pressure. They will be used very little in high-vacuum condensing service, for the reason that the turbine is better adapted to the extreme low-pressure ranges.

Engine units used in the high-pressure stages in combination with low-pressure turbines for the low stages of expansion, in condensing plants, will represent the highest development, capable of higher efficiencies and lower total investment, in many cases, than either engine or turbine units alone.

Investment costs of these high-speed engine-generator units completely installed will be less than for horizontal low-speed units. In itself, the engine unit generally will cost more than a turbine unit of equal capacity, but when taking the entire power plant cost into consideration it will be found that where efficiency in the prime mover is important the engine has a favorable advantage over the turbine under back-pressure operation.

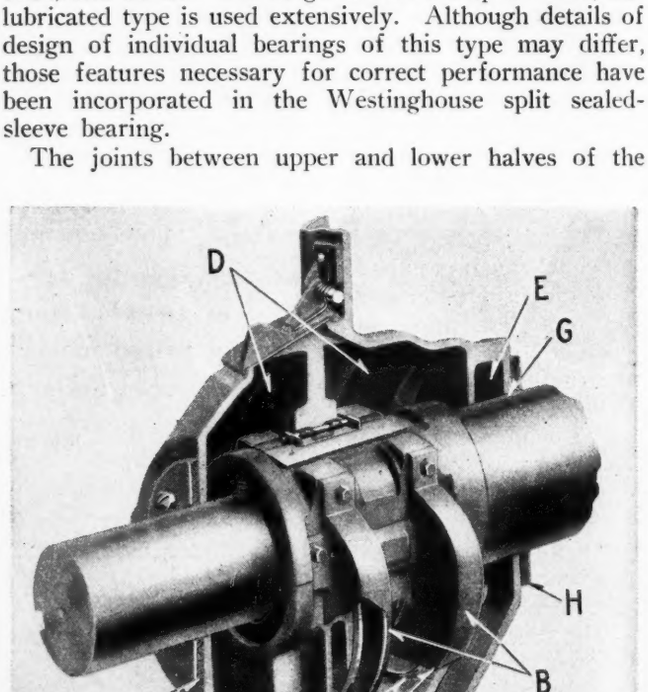
Ring-Oiled Split-Sleeve Bearings Made Leakproof

By J. L. Brown
Industrial Motor Engineer
Westinghouse Electric & Manufacturing Company

SUFFICIENT and proper lubrication of the bearings of large motors, with no oil leakage, is the ideal condition of operation desired by industrial and power engineers. With this in mind manufacturers of electric machinery have been working for a number of years on the design of leak-proof bearings suitably adapted to the trend of present-day motor design of more compactness, increased speeds, and artificial ventilation. Probably more than 50 per cent of motor-winding failures have been due to oil from the bearings escaping on to the windings, where it destroys the insulation.

Bearings for small and medium-sized industrial motors are of many kinds, such as ball, roller, solid-sleeve, split-sleeve, grease-lubricated, waste-packed, ring-oiled, and others. For large motors the split-sleeve, oil-lubricated type is used extensively. Although details of design of individual bearings of this type may differ, those features necessary for correct performance have been incorporated in the Westinghouse split sealed-sleeve bearing.

The joints between upper and lower halves of the



Section through seal-sleeve bearing for motors

split-bearing housing had seemed to make a leakproof housing of this type unattainable. The halves of the housing, although clamped together as tightly as possible by large bolts, provided between their mating surfaces innumerable capillary spaces readily accessible to oil as an avenue of escape from the housing, not only directly across the thickness of the housing wall, but also axially along the mating surfaces to any point where drainage is effected, as by the windage suction of a blower.

Observations disclosed that the oil gaining access to the joints between the halves of the housing was drainage from the interior walls of the upper part of the bearing housing. The oil deposit on these walls consisted of a multitude of particles, invisible for the most part, thrown off from the oil rings. Shaft shoulders adjacent to the bearing surface were usually well shrouded, thus avoiding escape of oil particles from this source, but oil rings were never fully guarded.

In the split sealed-sleeve bearing the oil rings and other sources of oil spray are inclosed at all points above the level of the oil in the reservoir, the inclosures forming part of the bearing itself. The air space within the housing around the bearing is thus entirely separated from the chambers in which the oil rings turn, so that the air in this space is free from oil spray at all times. The interior walls of the housing remain dry, and leakage through and along the joints between the upper and lower halves of the bearing housing is prevented.

Even the leakage induced by windage is avoided. Although a current of air induced by the suction of the blower may pass through the housing, it cannot pick up oil spray and vapor, because the housing is dry and clean.

A split sealed-sleeve bearing housing cut through the vertical center line to expose the bearing is shown in the figure. The oil rings *A* have a portion of one of their guards *B* cut away to expose the ring and disclose the shape of the inclosing chamber. The reservoir is filled until the lower edges *C* of the oil-ring guards are submerged about $\frac{3}{4}$ in. The oil-ring chambers are open at the bearing top, so that the rings' operation may be observed. The openings have a spring-closed felt-lined cover set in a depression, closing the oil rings off from the air chambers *D*. When the oil rings are a continuous circle, as in this case, separate guards *B* are bolted on to complete the oil-ring chambers. When the oil rings are jointed, so that they may be taken apart, the portions of the oil-ring chamber shown bolted on in the figure are cast integral with the upper and lower halves of the bearing.

At the inner end of the housing a separate annular chamber *E* is interposed between the bearing housing and the point where windage suction occurs. This chamber is vented to the external atmosphere by a duct *F* which supplies air leakage occurring through the annular clearance space *G* around the shaft, and avoids exposing air chambers *D* to high windage suction.

During operation, even at high speeds and with windage suction external to point *G* of two inches of water, oil leakage is absent. The interior walls of the housing forming air chambers *D* will be found to be dry. The joint between the upper and the lower halves of the housing, obscured by the shaft in the figure, does not require a gasket or filling cement of any kind. The felt washers *H* shown at the ends of the housing are not required to prevent oil leakage, being added for dustproofing.

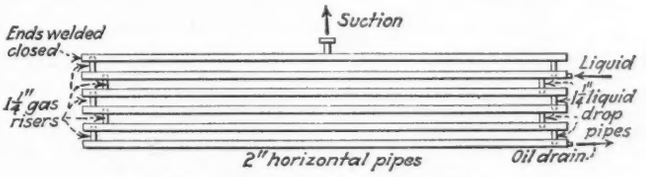
New Type of Ammonia Evaporator for Flooded Operation

By Robert Wheaton

IN CERTAIN types of refrigerating work where the liquids flow over cooling coils it is desirable to operate the coils flooded, because of the greater heat transfer that can be obtained thereby compared to direct expansion operation.

An accumulator is usually employed to obtain a flooded condition of the coils. When the liquid ammonia splashes up out of the coils it is thrown out of the gas stream and is conducted back into the coils, while the evaporated ammonia is taken away by the compressor. In the smaller size of installation, say around 5 tons, the accumulator amounts to a large item, not only in cost, but also in space requirements. Search for a means to simplify the evaporator and eliminate the accumulator resulted in the development of the coil shown in the sketch. It is an extremely simple arrangement wherein the top pipe acts as an accumulator and gas-drying chamber, much after the manner of a steam dome on a locomotive. Any liquid in the gas stream leaving the top gas riser is thrown out when the gas makes the right-angle turn, and the liquid falls down into the lower pipes for further evaporation.

It will be observed that the liquid feed enters at the second pipe from the top so that the flash gas can pass off immediately without choking up the coils. Unevaporated liquid passes to the left and downward; the lower coils thereby become flooded. As the liquid evaporates, the gas rises in a staggered pathway from one



The new type of cooling coil

pipe level to the next, and any unevaporated liquid spreads out to the right and drains downward through the liquid drop pipe. The gas risers extend from the ceiling of one pipe to the ceiling of the next pipe, while the liquid drop pipes extend from the floor of one pipe to the floor of the next. Gas cannot rise in the liquid drop pipes when the coil is in operation because the lower ends of the liquid drop pipes are submerged in liquid ammonia. The gas is evacuated promptly, for it does not have to travel a long distance through liquid ammonia, and the amounts of gas increase successively until the top pipe is reached, at which point the gas velocity is sufficiently high to insure liquid-free gas leaving the coil.

These coils have also given good results in freezer rooms where quick-frozen foods are held in storage. In this work the coils are mounted in pairs on stands along one side of the room.

✦

Ringlemann Smoke Charts—Many cities are conducting active campaigns against smoky stacks. For the engineer to be sure he is not violating an ordinance he should use a smoke chart. *Power* has several hundred copies of these printed on heavy cardboard which engineers can obtain free upon request.

FIRING with Pulverized

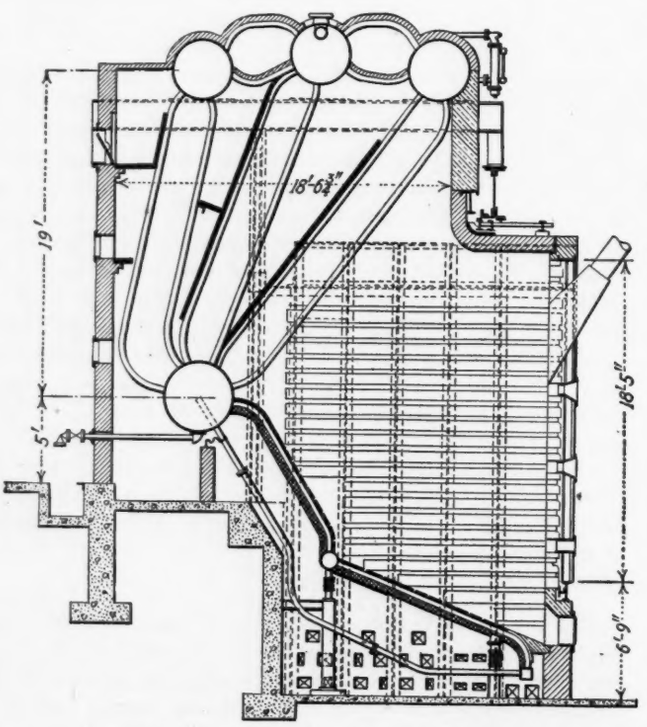
Pitch Residue and Coal

By MARK BUSKAVETA
Assistant Works Engineer
The Newport Co., Carrollville, Wis.

Forty per cent of the power demand is generated as a byproduct of the process steam. The company's experience in substituting unit mills for underfeed stokers 12 years old is of interest. Fuels used are pitch residue and Illinois coal

AT THE plant of the Newport Company, a manufacturer of dyes and chemicals situated at Carrollville, Wis., power is generated as a byproduct of the low-pressure process-steam requirements. About 40 per cent of the electrical demand, amounting to 1,200,000 kw.-hr. per month, is generated in this way, and the exhaust or extracted steam goes to process. The balance of the electrical load is purchased. Steam is generated at 200 lb. pressure by eight 4,000-sq.ft. Stirling-type boilers. The load averages about 110,000 lb. of steam per hour during the winter months. In the summer it is about 90,000 pounds.

Principal equipment in the engine room includes one 1,000-kva. extraction turbine-generator equipped with a low-head jet condenser; two 1,260-cu.ft. and one 2,000-cu.ft. steam-driven air compressors; one 150-ton and one 250-ton ammonia compressors used on a brine-circulating system, and one 50-ton ammonia compressor on a 25-ton can-ice plant.



Furnace arrangement of the last boiler converted to powdered coal

As the manufacturing plant is run on a 24-hr. basis, the demands on the power house are fairly constant, the load during the day being only slightly more than at night. Air requirements are about 3,000 cu.ft. per minute. Brine circulated through the various departments requires the equivalent of 180 tons of refrigeration per day, while the ice plant produces about 22 tons of ice per day. Water requirements are furnished by a 14,000-gal.-per-minute pumping station located on the shores of Lake Michigan about 500 ft. from the center of the plant. The amount of water used is about 6,000 gal. per minute.

All turbine- and engine-driven units mentioned in the foregoing paragraphs produce their respective forms of power as a byproduct of the plant low-pressure steam requirements. Several units in the boiler room and in the plant also exhaust into the low-pressure steam mains. In all, about 2,500 hp. is derived in this way. By extraction from the turbine, about 500 hp. is available as a byproduct from a 50-lb. pressure line. Producing 2,500 hp. of byproduct power at a saving of 0.4c. per horsepower-hour over condensing operation, means a saving of $7,200 per month. This is further accompanied by a marked reduction in boiler capacity over what would be required if the engines were operated condensing and the plant process supplied directly from the boilers.

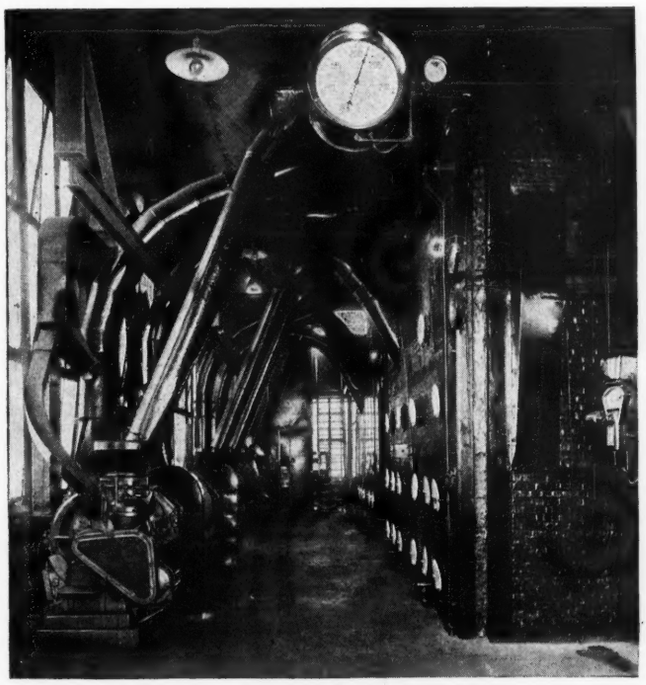
Previous to 1926 the boilers in the plant were fired with underfeed stokers. Late in 1925 the attention of the company engineers was directed to the possibilities offered by pulverized-fuel firing, with respect to the possible gains in capacity and efficiency. Preliminary investigation of the subject indicated increased efficiency and capacity available at a unit cost aggregating 75 per cent of that of the boiler room. A decision was reached to change one stoker-fired boiler to pulverized-fuel firing and to use as a fuel pitch residue from coal tar distillation, a limited supply of which was available from a near-by plant. Because of its high calorific value, 16,071 B.t.u. per pound, and the absence of ash and moisture, the pitch appeared to be an ideal fuel to use in pulverized form. Its low melting point, 260 deg. F., made it un-

suitable as a stoker fuel. A typical sample of the pitch received at this plant shows: Moisture, 0; volatile matter, 49.91; fixed carbon, 49.74; and ash, 0.35 per cent.

Owing to space limitations, lower cost, and because of the low melting point of the fuel, a unit-type impact mill was selected. The furnace volume was increased to 2,300 cu.ft. by moving out the front wall about 6 ft., and removing the stoker ashpit and windbox. In view of the absence of ash, the impossibility of using preheated air through the machine with pitch as a fuel, and because of the lack of definite data at that time regarding the performance of air- or water-cooled walls and bottoms, it was decided to build the first furnace with a solid refractory wall.

A burner of the fish-tail type, entering the furnace through the front wall about 4 ft. below the arch at an angle of 35 deg., was selected. It was designed to pass about 35 per cent of the air required for combustion. Secondary air was admitted through butterfly doors in the front wall.

Early in 1926 the unit was placed in operation, and the results obtained were, in general, up to expectations. The high volatile content of the pitch required a long flame path to insure complete combustion before the gases entered the tubes. Turbulent mixing of gas and air was impractical because of the narrow furnace width. By increasing the primary air to about 50 per cent and maintaining the furnace draft at 0.05 in., the flame could be made to descend to the bottom of the furnace, but at ratings in excess of 150 per cent the flame would strike the tubes, secondary combustion would develop, and the boiler efficiency would drop off. The flame would impinge on the side walls; but with no ash the erosion of the refractory was not serious.



Four of the boilers equipped for pulverized fuel firing

To provide longer flame travel and prevent impingement on the side walls, the burner was shifted to feed through the arch, and its cross-sectional area was reduced to give a Venturi effect.

Since the relocation of the burner no trouble has been experienced from the flame striking the tubes up to the maximum rating carried, 225 per cent. The flames can be kept clear and transparent over the entire range of operation, from 75 to 225 per cent rating, with no smoke issuing from the stack.

Results secured from the initial installation with respect to continuity of service, efficiency, rating and low maintenance were such as to warrant the conversion of additional units to pulverized-coal firing. At the present time four units are fired with pulverizers, while four are fired with stokers.

As the local supply of pitch was limited, it was decided to fire the succeeding units with coal. With several minor exceptions, furnace design and pulverizing equipment were the same. By the middle of 1927 two units were in operation with coal as fuel.

As with the first boiler, a furnace volume of 2,300 cu.ft. was provided. The heat release was approximately 11,000 B.t.u. per cubic foot at 150 per cent rating. The front, side and bridge walls were made of solid refractory, with a sloping refractory floor. Butterfly doors through which secondary air was admitted were placed in the front wall. The ash doors also were used to admit some secondary air to prevent the ash's fusing in the furnace bottom.

A burner of the horizontal turbulent type was installed at the center of the furnace, but owing to the wide flare and the narrow width of the furnace the flame impinged on the side walls and caused rapid erosion. Reducing the angle of the flares lessened the wall erosion but increased the carbon loss. The horizontal turbulent burner was replaced by a vertical burner that enters the furnace through the arch at an angle of 12 deg. and about 18 in. from the front wall. This burner has a furnace opening measuring 8x22 in. It is made of $\frac{1}{8}$-in. sheet steel and is provided with a jacket for water cooling. Since its installation no serious deterioration of the side walls has occurred.

Ash in the furnace bottom would melt and become sticky, making it extremely difficult to remove with a hoe and necessitating frequent boiler outage so that men could enter the furnace and remove the accumulation. The coal used had an ash fusion temperature of about 2,100 deg. and an ash content of 10 to 12 per cent. A change of fuel to coal having an ash content of 6 to 9 per cent and an ash fusion temperature in excess of 2,500 deg. F, resulted in a marked improvement in operation.

It was believed that a water-cooled bridge wall and hearth would raise the furnace heat release, thus increasing the rate of operation, and keep the ash from fusing. About 135 sq.ft. of water-cooled surface was installed in each of the two furnaces burning coal, and the side and battery solid refractory walls were replaced with air-cooled refractory construction. A marked improvement in efficiency was obtained by reducing the excess air.

During the past year these boilers have operated about 320 days each, and only once was it necessary to take a boiler off the line to clean out the ash accumulation. In that instance the trouble was caused by operating at high rating for a period of 35 hr. on Illinois coal having an ash fusion temperature of 2,100 deg. F. Ordinarily, the ash is removed with hoes through access doors in the basement. It is pulled out of the furnace into a sluiceway, from which it is washed into a short section of sewer discharging into a creek.

When the coal-fired units were first placed in operation trouble was experienced with the coal feed, owing to the inability of the crushers to deliver a uniformly fine product, and it was impossible to maintain a constant

load or furnace condition. The difficulty was overcome by the installation of a ring roll crusher, which delivers a product that will pass a ¾-in. mesh.

The feeder, consisting of a revolving cone-shaped corrugated disk with a knife set to scrape the coal into the machine, was driven originally from the pulverizer shaft. Later this drive was replaced by a small variable-speed direct-current motor. Since these changes were made no further trouble has been experienced, and constant load and furnace conditions can be maintained with little attention.

Under average conditions the mills require approximately 23 kw.-hr. per ton of coal pulverized, but the power requirement varies with the moisture content of the fuel and the capacity at which the mill is operating. Coal so high in surface moisture that it was possible to squeeze out water, has been pulverized, but a marked reduction in boiler capacity and efficiency resulted. Average fineness of coal delivered is: through 200 mesh, 60 per cent; through 100 mesh, 85 per cent; and through 50 mesh, 96 per cent.

By moving the hammers progressively toward the feed end about 1,250 tons can be pulverized before replacement is necessary. By changing the hammers progressively, those in the last stage, which control the percentage of oversize, are maintained in good condition. Average life of the liners has been about 6,000 tons, while the diaphragms require replacement after approximately 4,000 tons. No appreciable wear of fan blades or fan casing has occurred.

Another unit has just recently been converted to pulverized-fuel firing. The equipment includes an impact type pulverizer having a capacity 1,000 lb. per hour greater than the units previously installed, not only to provide higher capacity, but also to assure operation at 150 per cent rating when firing coal having a moisture content of 18 per cent. The furnace bridge wall and hearth contain 135 sq.ft. of water-cooled surface. The side, front and battery walls are of air-cooled refractory construction. Air from the walls going to the pulverizer at a temperature of 350 deg. F. has proved of marked advantage when handling wet coal.

Ordinarily, the boilers are operated at a continuous rating of 150 to 175 per cent for a period of 90 days, when they are taken off for cleaning. Although the rating is low for a pulverized-fuel boiler, experience with this installation has indicated it to be the best rating at which to run, considering continuity of service, efficiency, and furnace and boiler maintenance. Because the steam demand is constant, the boilers are operated at a constant load at all times, so that little manual operation is required to maintain any desired furnace condition.

The pulverized-fuel boilers are equipped with steam flow meters, CO_2 recorders, flue-gas temperature recorders, and draft indicators. A V-notch meter records total station load.

Boiler efficiencies are plotted daily. Weekly and monthly heat balances are used to check boiler-room performance. A monthly steam-heat balance is made, showing the steam distribution to all engine room, boiler room, and plant steam power units, as well as the steam consumed in plant process work at 5, 50 and 200 lb. pressures. All steam is charged on a B.t.u. basis. The boiler efficiency over a yearly period is 73 per cent, while the load carried approximates 150 per cent of rating. The average total plant load carried by the pulverized-fuel boilers is 53 per cent.

The fuel cost of steam generated per 1,000 lb. by the pulverized-fuel boilers is 83 per cent of that of the stoker-fired boilers. It must be kept in mind that the stokers were installed twelve years ago. The conversion cost is about the same for both methods of firing.

During the past twelve months the station generated 820,000,000 lb. of steam. If all the steam had been generated in stoker-fired units the fuel cost would have been $228,000, while the same output from the pulverized-fuel units would have cost $191,000, a difference of $37,000.

Fuel savings on the pulverized fuel units show a gross return on the investment of about 33 per cent. The investment was justified solely from the standpoint of fuel saving, but there was a further gain in the ability of the units to carry a 50 per cent higher load continuously than was possible before revamping. This increased capacity has been secured at an investment cost of less than 75 per cent of the investment characteristics of the boiler house.

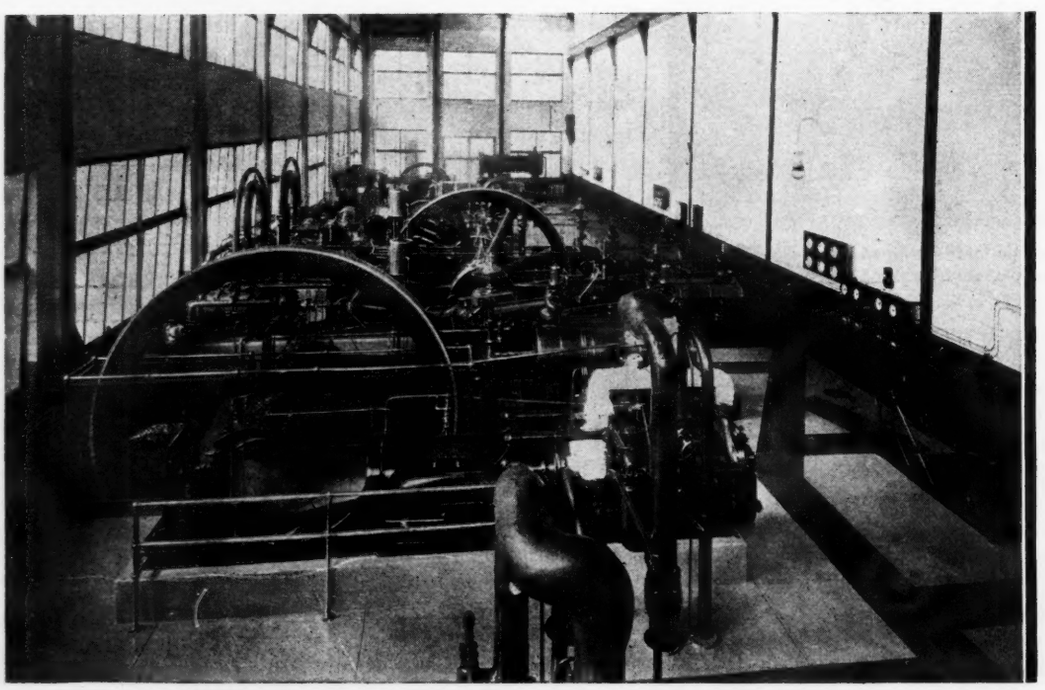


Fig. 2—View in engine room, with ammonia compressor in foreground and extraction turbine unit at the far end

A Million Dollars for Fire Protection Service

By W. H. Cochrane
Assistant Secretary, Bush Terminal Company

AMID THE mass of appalling information concerning destruction wrought by fire the story of Bush Terminal's experience with its own system of fire protection stands out as a constructive and encouraging achievement.

During the five years preceding 1905 there were several serious fires at Bush Terminal, with losses running into millions. In one warehouse stored with cotton the fire department fought fire for thirty-eight days. Another fire burned for seven hours, with twenty-five streams played on it by twelve engines, one water tower, four hook-and-ladder companies and four fire boats. As landlord of piers, warehouses, and loft buildings providing 12,000,000 sq.ft. of floor space, the Bush Terminal Company came to consider itself responsible for safeguarding from fire the structures housing 300 tenants.

Consequently, it was decided to install an automatic sprinkler system. It required 132,000 sprinkler heads on both wet and dry pipe lines, the latter for piers and buildings where the temperature may drop below freezing. Then came the difficulty of tying it up with an automatic fire-alarm system. When it was announced that a working system could be devised not only for automatic alarms to be rung when heat from fire reached a given point, but also for signals to be received at the central fire station immediately on the closing of any control valve, and for the valve house or point of connection between the dry and wet pipe lines to be kept above the freezing point, the insurance underwriters said that anything of the sort was unknown.

The heart of the system is at the end of a single-story building just back of one of the piers. In this room are two 1,500-gal. pumps, which supply water to the sprinkler heads. There are two trunk lines of electric wiring and two automatic control cabinets that start the pumps working. In short, all the equipment is in duplicate, so that if any part gets out of order a switch can be thrown to the other line and service continue uninterrupted.

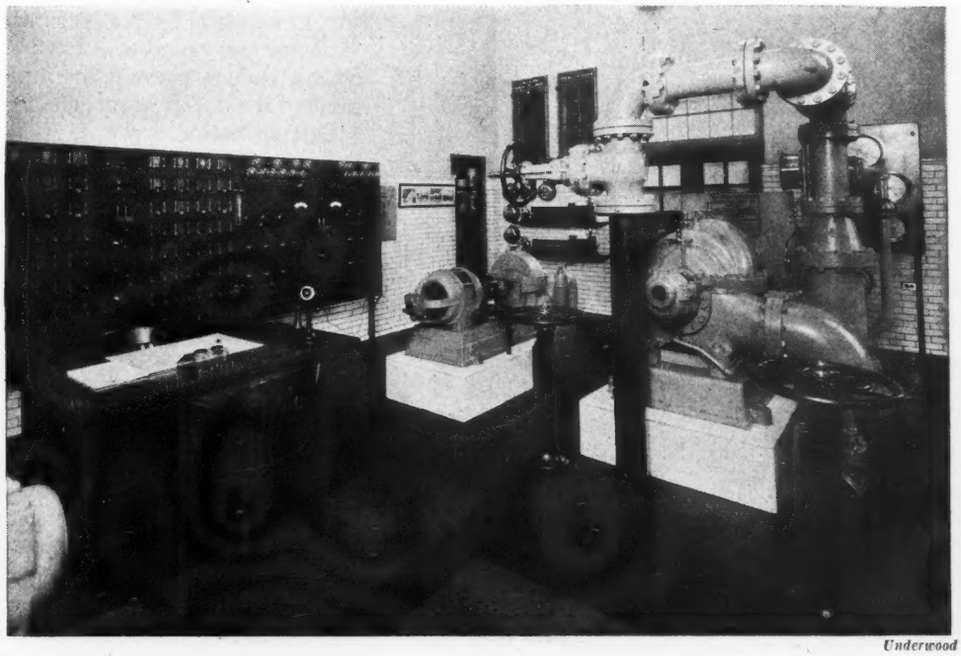
In this central fire station there are also six large gongs for the Bush Terminal fire-alarm system, one connected with the city fire department, and one automatic device for sending alarms to the fire boats in the harbor.

Individuals discovering fire may ring in an alarm from the nearest box, but when undiscovered and heat from a fire becomes sufficient to operate a sprinkler head, an automatic mechanism rings the alarm. This alarm is not only noted in the central station, but also at the building where the fire has occurred.

It may be answered either from the central fire station or from a substation near a group of shops. Workmen in these shops, chosen with care and properly instructed, answer the call. Although reaching the scene in surprisingly short order, they usually find the blaze well under control, if not entirely out. When new sprinkler heads have been installed and the entire system checked over to see that it is in working order, the men signal back to the fire station. The ticker tape there must register not only the number of the box from which the alarm came, but also the payroll numbers of the shop men who answered it.

Pressure is maintained on the wet pipes, which comprise over half of the system, by water tanks located on the building roofs. The capacity of these tanks averages about 570,000 gal. per building, and they maintain pressures ranging from 90 to 65 lb., depending on the height of the building served. A small 50-gal. pump, located in the control room, is in continuous operation; its capacity being just sufficient to make up for leakage and keep all tanks full.

When a fire occurs and a sprinkler head goes off the flow of water to that section of the building operates a Venturi alarm valve located in a tunnel outside of the building. The mechanism of this valve, in turn, electrically operates an alarm box. The alarm box sends its signals to the control room, where it automatically starts one of the main 1,500-gal. fire pumps and indicates the location of the fire. The system of protection from fire at Bush Terminal cost $1,000,000, but it has saved many millions.



Underwood

▼

Central fire station at the Bush Terminals

Waterwheels As Emergency Drive on Sump Pumps

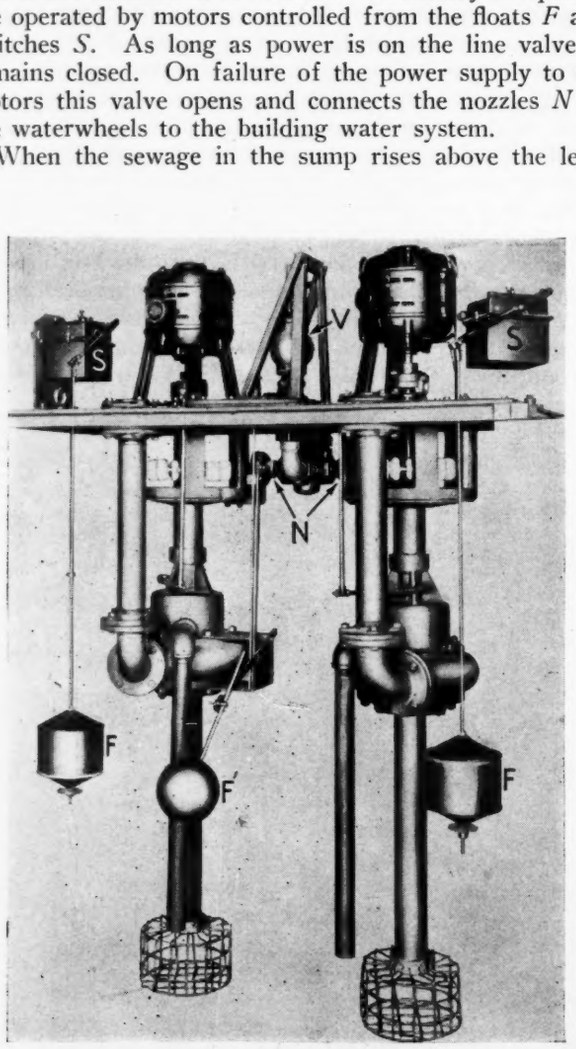
WHERE pumps are employed to discharge sewage or other waste from a building it is general practice to use two pumps in the same sump. The pumps are started and stopped by float switches and arranged so that one pump takes care of normal conditions and the other is held in reserve. This is done by setting the floats to start the pumps at different levels of liquid in the sump. The pump operating on the low-level float starts first and normally keeps the sump empty. In case this pump fails or the inflow happens to be greater than one pump can take care of the second pump is put into operation by the high-level float.

If the power supply is 100 per cent reliable the foregoing arrangement insures almost perfect reliability in the pumps' operations. There is only a very remote chance that both pumps will fail at the same time. When there are possibilities that the power supply will be interrupted, an emergency means must be provided to drive the pump. The Byron Jackson Pump Co., Berkeley, Calif., had this problem put up to it and solved the difficulty by installing a small impulse waterwheel between the motor and the pump, as in the figure.

The pumps are installed in a building sump in Los Angeles. The sump is so located that it is imperative that it not be allowed to overflow. Normally the pumps are operated by motors controlled from the floats F and switches S. As long as power is on the line valve V remains closed. On failure of the power supply to the motors this valve opens and connects the nozzles N of the waterwheels to the building water system.

When the sewage in the sump rises above the level at which the high-level float switch cuts in, float F' opens the waterwheels' nozzles and the pumps start. The pumps have sufficient capacity to handle both the sewage and the discharge from the wheels. Unless the head obtained on the water mains is about three times that on the sump pumps this system cannot be used. With a low head on the wheels it is possible to discharge more water into the sump than is taken out.

Where conditions are suitable for their operation the waterwheels provide a simple and reliable emergency means of driving the pumps. When it is certain that an attendant will always be near the pumps the valve in the water line can be manually operated and an alarm used to call attention to high water in the sump. If the pumps' motors will not operate, the attendant can open the valve in the water-supply line and run the pumps on the waterwheels.



Two motor-driven sump pumps with waterwheels located between the motors and pumps

A Plant Engineer's Suggestions for Safe Operation

HAVE sufficient exits in all transformer and switch rooms to prevent the possibility of any one being cut off from escape in case of an electrical fire.

Do not change burned-out lamps in high-voltage compartments unless the electrical superintendent is present.

Stencil the name of the drive on the line switch and the control equipment, as well as the feeder number. This will reduce the time required to open the switch or to stop the machinery in case of an emergency.

Whenever possible install all starting equipment in view of the machine that it drives.

Do not start any piece of equipment from more than one point.

Install emergency stop buttons in places where accidents are likely to occur.

When a double-throw switch is used ahead of a compensator to reverse a motor, stencil a sign on the switch: "Trip Starter Before Opening Switch."

Discard all metal danger signs.

Inspect all pressure tanks at regular intervals, especially those used for compressed air. This inspection should be made by the boiler inspector if possible.

Motor pulleys should have the rim flush with the hub on one end, to prevent the pulley's overlapping the bearing and making it hazardous to inspect or oil the bearing.

The adjusting screw in the motor base for tightening the belt should be on the side of the motor opposite to the line wires. This is to remove the hazard connected with using a wrench around the wiring.

All truck handles should be so constructed that they will automatically assume a vertical position when turned loose, or a catch provided on the end of the truck body to engage the handle, to prevent its lying across the floor.

All extension cords used in boilers, tanks and similar places should be provided with a rubber protection over the socket end splice.

Belts in aisles or other places where workmen are frequently near should be provided with a steel plate guard in front of the belt's line of travel, to hold it in case of a rip or break.

Stairs and walkways around wet machines should be equipped with non-slip treads. Exposed parts of machines' bedplates are also hazards, especially when oily, that should be protected against.

. . . RIGHT OUT OF THE PLANT . . .

Electrical Soldering Device Uses Carbon Electrodes

LIMITATIONS imposed by the customary use of electrically or flame-heated soldering coppers can be removed by using a device that heats the parts to be soldered by alternating current flowing at low voltage Such a soldering outfit is shown in the figure. It includes a small transformer to connect to a lighting-circuit and supply power at approximately 5 volts. The low-voltage transformer terminals are connected through extra-flexible leads to brass electrode holders. The electrode holders are clamped between two pieces of ebony asbestos, thus forming a handle. Carbon rods of ½-in. diameter comprise the electrodes.

Before this soldering device can be effectively used the exterior of the part to be soldered must be sufficiently clean to enable current to flow. With the transformer's primary energized the carbon electrodes are placed firmly against the parts to be soldered, being held in the position most convenient for the operator. Shortly after current flows the carbons attain a high temperature, usually glowing red or white. The heat from the carbons, and that due to the contact resistance, rapidly spreads, and the solder soon flows freely. Part of the heating is due to the current, approximately 125 amp. that flows through the part being heated, but the greater heating effect seems to be due to the high temperature of the carbon electrodes

It is unnecessary to use a torch or soldering copper in conjunction with this equipment. With a little practice all kinds of soldering can be quickly and neatly done This method of electrical soldering is especially applicable to bar windings, where connections practically out of reach of a soldering copper can be readily soldered.

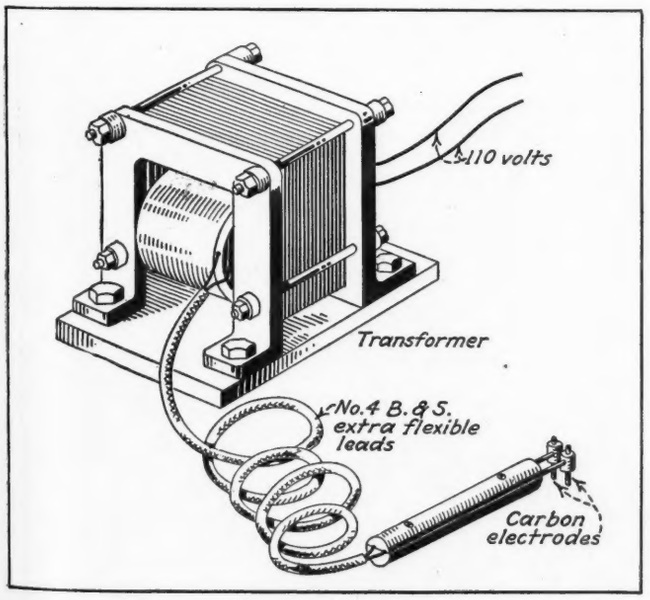


Diagram of soldering device connected to its transformer

When small parts are to be soldered a suitable soldering copper can be quickly heated by simply being placed in contact with the electrodes. By using a larger transformer and larger electrodes, so as to utilize more current, the largest soldering jobs can be handled without trouble.

GEORGE PARSONS.

Pittsburg, Calif.

Overcoming Voltage Fluctuation With Induction Motor Load

SOME TIME AGO the question was asked in the From Among Readers' Problems section "What should be done to remedy the trouble of lights dimming when one of the induction motors is thrown on the line?"

It is assumed that the engine will carry the full load of 125 kva. at unity power factor without slowing down; alternator field regulation is done by hand to maintain full voltage at various loads; lighting load is proportionately much less than the motor load; and mostly all motors are of the induction type, either squirrel-cage or slip-ring, and usually of small sizes.

Now the reason for lights getting dim when one of the induction motors is thrown on line is the increased induction load on the generator, which causes a voltage drop owing to wattless current flowing in the generator windings. As field regulation is by hand, considerable lag exists, and before the regulator can be adjusted the voltage drops. This is for light loads. But when the generator is under practically full load, the maximum regulation is already made, and if another motor is thrown on line the voltage will at once fall, and further regulation cannot be made or the wattless current further reduced. To overcome this trouble the following changes are suggested:

1. At least 50 per cent of the motor load should be taken by synchronous motors and the present induction motors of equivalent capacity should be replaced by such motors.

2. If such change is not possible, a static condenser of sufficient capacity should be installed on the power main on the load side.

3. If the engine slows down with the increase in load, adjustment of the governor or throttle valve should be made.

4. In place of hand regulation, an automatic voltage regulator should be installed to obtain full voltage at all loads.

5. As the generator is a 125-kva. machine, it is rated

at some power factor, say 80 per cent. If the motors are not selected of suitable types to obtain the full capacity of the generator, the capacity is greatly reduced by too much induction load of low power factor.

6. If approximately half the present induction motor capacity can be replaced by one or two synchronous motors, it will improve the whole installation and considerably more power will be available without any additional increase in steam consumption.

Ahmedabad, India. M. M. VYAS.

Experience Starting Squirrel-Cage Motors on Full Voltage

THE comments relative to full-voltage starting of large squirrel-cage motors in the April 15 number of *Power* were interesting and gave the general impression that this method is one much to be preferred. I am afraid that many readers will not appreciate the full significance of Mr. Wilson's warning contained in his statement "Where machines have considerable lost motion in their gearing, such as in chain drive, full-voltage-start motors should be applied only, if at all, after a careful consideration of the effect of the sudden starting on the driven machine."

There are many applications where across-the-line type starting is desirable, but there are likewise a great number of instances where such a motor was considered a cure-all and applied without a thorough knowledge of all of the factors involved. The sudden start produces a strain on all parts far in excess of that which is present during normal full-load operation. I have seen many cases where pulleys and belts have been ruined due to the quick starting of double-squirrel-cage type motors.

In one case involving a 30-hp., 3,600-r.p.m., ball-bearing, double-squirrel-cage motor used to drive a centrifugal grinder, the full-load current was 68 amp. The starting current was in excess of 200 amp. and it was necessary to supply fuses of 200 amp. in the line. This meant a larger line switch, a larger switch in the feeder panel, and larger fuses in the incoming power service panel. Furthermore, the customer spent considerable time looking for trouble in the driven device and in the motor, whereas there was no trouble other than heavy fuses were required for the high starting current.

Bear in mind that many of the industrial plants do not have electrical experts on the job who can advise them regarding all of the factors attendant to the installation of a double-squirrel-cage motor. According to my experience, they will be benefited to a greater extent by applying the old single-squirrel-cage motor with a compensator or a slip-ring motor for heavy and gradual starting, than they will by the indiscriminate use of a double-squirrel-cage motor.

Many have welcomed this comparatively new type of motor with outstretched arms, feeling that it is a cure-all for all motor application problems. They have overlooked the fact that the method of starting is only one of a number of factors that must be considered in the proper application of any particular motor. It may be of interest to know that the double-squirrel-cage type motor was devised by F. P. Boucherot in 1898.

M. M. ROSE, *Sales Engineer,*
Cleveland, Ohio. The Fuerst-Friedman Company.

Danger in Using Volatile Oils on Diesel Admission Valves

I THOUGHT it might be well to call attention to a necessary precaution in the use of kerosene mixture for lubricating the valve stems of four-stroke-cycle Diesel engines. Some engine manufacturers prescribe two-thirds kerosene and one-third oil as a lubricant for the admission and exhaust valves. The kerosene is to prevent carbon from forming on the valve stem and seat.

With this mixture I have found that care must be taken not to use it too freely, especially on the admission valves. An oversupply will be drawn into the cylinder and vaporize into a combustible mixture that will preignite and cause a detonation. This precaution is not necessary with the exhaust valve because there is no tendency for the mixture to be drawn in, and it is discharged with the exhaust gases. ART WILLIAMSON.

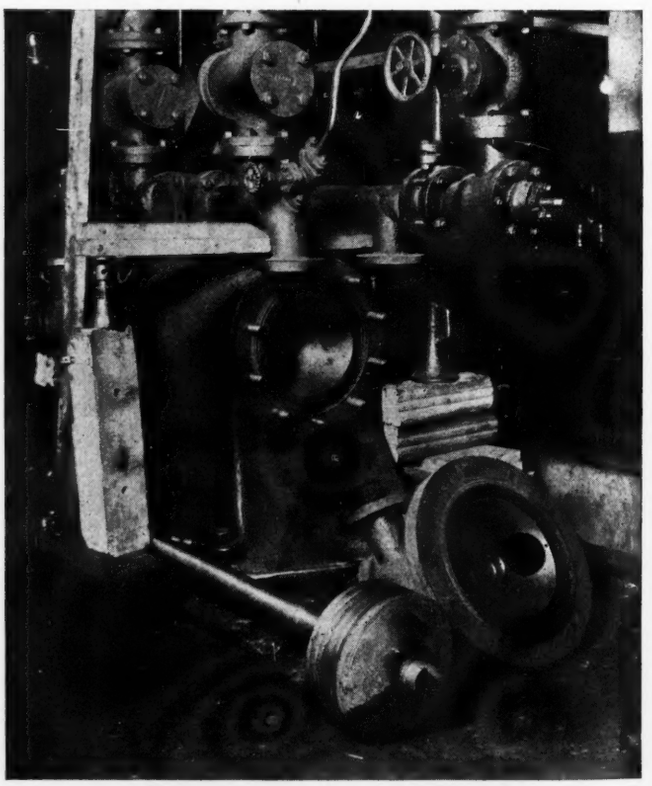
Kimball, S. D.

Welding Reduces Repair Costs on Ammonia Compressor

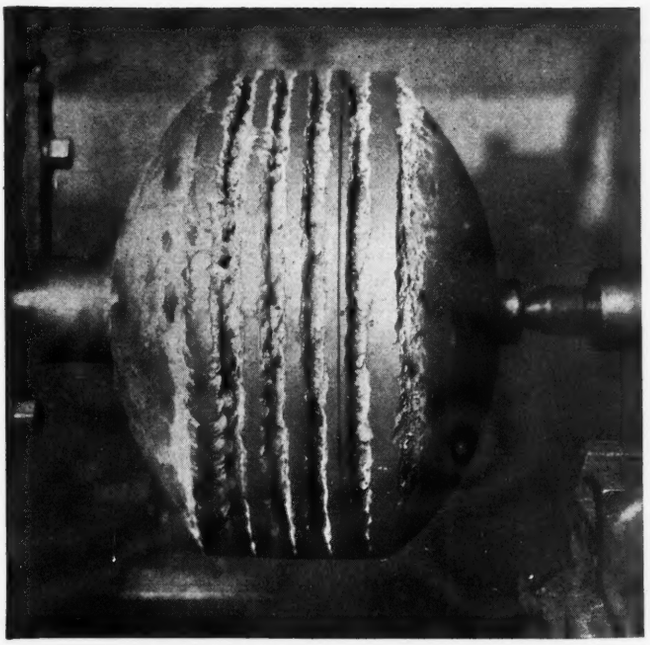
ONE of the many problems of the man in charge of a refrigerating plant is that of keeping the cylinders of the ammonia compressor in good operating condition. This necessitates boring out the cylinder from time to time and fitting a new or oversize piston.

As this usually involves considerable expense unless one is well equipped to do it with the regular staff, the work is often put off, with the result that the efficiency of the compressor is considerably reduced.

In our plant, in place of fitting a new piston we have the old one built up by oxy-acetylene welding at a local shop; then it is turned down in our own lathe to the



View of finished piston and rebored cylinder



Built-up piston mounted in lathe for machining

required size. The cylinder is also rebored by our own machinist. In this way we have been able to keep the repair charges on the compressor down to a minimum.

E. W. HALL, *Mech. Supt.*
Saskatchewan Co-operative Creameries, Ltd.
Regina, Saskatchewan.

What Is An Engineer?

I HAVE before me an invitation to identify myself with the American Association of Engineers. This organization is a meritorious one and is attempting to effect a much-needed improvement in the standards of the engineering profession by imposing certain limitations on the people permitted to practice engineering or pursue engineering work. An attempt is being made to provide legislation which will compel the registration of engineers in all states. In some states laws have already been passed for this purpose.

Very evidently the American Association of Engineers expects its members to be competent to qualify as registered engineers. This association grants senior membership to "any person of good moral character, at least thirty years of age, who shall have been or is actually engaged in the practice of professional engineering and who shall possess the qualifications requisite for corporate membership in any one of the founder societies." It is understood that the founder societies are the present national organizations, including the American Society of Civil Engineers, the American Society of Mechanical Engineers, the Institute of Electrical Engineers and some others.

There is no question in regard to the importance of providing a standard of engineering competence. It is a matter which concerns not only the engineers themselves, but the general public as well. How unsatisfactory the mere registration of engineers would be seems quite obvious. Without some thorough and impartial means of determining qualifications there would be little improvement over present conditions. Practically all other professions, including medicine, dentistry, pharmacy, and law, require some special qualifications of its members before they are permitted to practice at the expense of the public. There have been no such limitations imposed on engineers. The result is that the profession has been overrun with "quacks," much as the medical profession was a number of years ago before a system requiring the completion of a course in a college of good standing and the passing of a state board examination was instituted.

Under the present system, any individual with some natural ability as a salesman or promoter who has happened to have been connected with some engineering office for a few years, who has learned to read some classes of drawings and who has acquired a vocabulary of technical terms can easily talk himself into a responsible position. Often as chief engineer of some organization I found myself working for such a person.

Although these men had qualified as senior members in the national engineering societies, whose membership the American Association of Engineers proposes to use as a criterion of ability, they could not make simple calculations requiring only the most elementary algebraic operations, they know practically nothing about metallurgy, the symbols for simple chemical elements or the significance or operation of Ohm's law. In fact, one of these individuals stated on one occasion that he was glad that he "did not have a lot of such useless information to confuse his mind."

It is generally known that the untrained, and usually incompetent, engineers as a class are jealous of men having better mental equipment than themselves. The more incompetent they are the more annoying they usually make matters for trained engineers coming under their authority, and the more detrimental they are to engineering progress. Well-trained engineers cannot respect such members of their profession, if they are permitted to be members, as they are at present, and would not care to co-operate or consult with them any more than the well-trained physician of today would care to identify himself with one of the "quacks" of a half century ago. These individuals, while they may be able to create favorable impressions on the officials of the corporations by which they may be employed, and be able to maintain their connections with them for long periods of time by various means, are nevertheless felt to be a serious detriment to the general public as well as often a disgrace and discouragement to the engineering profession which they represent.

In order that the engineering profession reach the position of dignity that it should among other professions, it is necessary that a method of selection be employed in which a practitioner is compelled to show that he has expended some time and effort in preparing himself for his life's work and then by actual demonstration, and not by mere reports of professional connections, show that he has acquired the knowledge necessary to occupy a position of trust in that particular profession.

It is felt that no engineer should be permitted to practice his profession, to select materials and make other decisions in engineering construction, who has not sufficient knowledge in the various branches of mathematics, in mechanics and general physics, in metallurgy and chemistry to proceed independently and intelligently in the selection of materials and in the proportioning and distribution of these materials to avoid the loss of life or property in the use of the structure on which he may be employed.

C. M. NEWELL.
Cleveland Heights, Ohio.

From Among Readers' Problems

Conducted by
L. H. MORRISON

CORRECTING POWER FACTOR — *What would be the saving from correcting the power factor in our plant? The load on the 230-volt three-phase generators is 600 kw. and the power factor 0.68 to 0.70. The generators are driven by Corliss engines.* A.J.B.

The savings obtained will vary widely with the conditions under which the plant operates. Assume that there is plenty of generator capacity to supply the load and that the voltage regulation of the system is satisfactory, then the only gain will be a reduction of the losses in the system, which will not be of sufficient size to warrant spending very much to correct the power factor. If some of the motors can be interchanged to get better loading and power factor, it may pay to make the change. Or if some load is being added to which a synchronous motor may be applied the power factor obtained will be worth the small additional expense incurred.

On the other hand, if the generators are nearly loaded and the voltage regulation of the system is poor it might pay to install static condenser or other corrective apparatus to raise the power factor to 0.90 or 0.95. In this case, in addition to reducing the losses in the system, needed generator capacity is obtained and the voltage regulation of the lines is improved.

The problem cannot be worked out unless all the operating conditions are known, but the foregoing will show how the solution is affected by local conditions. The answer to this problem should not in any way be taken as applying to where power is purchased. Here a different set of conditions is encountered.

POWER REQUIRED FOR STREAM FROM FIRE HOSE—*What horsepower would be required to be developed by a motor to drive a pump for throwing a stream of water from a 1⅛-in. nozzle on 100 ft. of fire hose to a height of 100 ft?* W.D.

A stream from a 1⅛-in. smooth-bore nozzle, deflected about 15 deg. from vertical, can be projected to a height of 100 ft. in a still atmosphere with a pressure of 60 lb. per square inch in the stream at the exit of the nozzle. The delivery will be about 288 gal. per minute, with about 80 per cent of the water delivered to the full height.

The frictional resistance of best-quality rubber-lined 2½-in. fire hose, when delivering the quantity of water stated and laid without kinks or short bends, is about 15 lb. per square inch, and the total head pressure required at the pump delivery would be about 75 lb. per square inch. The quantity, 288 gal. per minute, would require pump displacement of $288 \times 231 = 66{,}528$ cu.in., and 75 lb. head pressure would require development of $\frac{66{,}528 \times 75}{12 \times 33{,}000} = 12.6$ water-horsepower.

Assuming that the efficiency of the pump is 60 per cent, the net power required of the motor would be $12.6 \div 0.60 = 21$ hp. With rougher lined, kinked or a smaller size of hose the frictional resistance would be much increased and more power would be required.

SURGING OF WATER IN BOILER GAGE GLASS—*What causes continual rising and falling of water level in a boiler gage glass?* R.G.N.

Surging of the glass-gage water level usually is due to alternate banking up and falling of the water level in the boiler over the point where the water column is connected to the water space of the boiler, due to oscillation of the whole body of water, induced by circulation of the water or by boiling. Or surging in the glass gage may be due to variations of pressure in the steam connection of the water column, caused by drafts of steam taken out of the boiler near the point where the steam connection is made for the water column.

PREVIOUS QUESTION

Discussed by Readers

THE QUESTION

WE USE an average of 2,000 kw. per hour, generated by a condensing steam turbine with a water rate of 15 lb. At the same time we are using for processes 20,000 lb. of steam at 30 lb., and 3,000 lb. at 90 lb., through reducing valves from the boilers. Our electrical load has increased so that we will shortly need to have 1,000 kw. more capacity. The boilers are built for 200 lb.

Will it be better to install a bleeder turbine to draw off at 30 and 90 lb. or install a back-pressure turbine to handle all the load? P.C.B.

EXTRACTION of steam from a turbine at a pressure of 90 lb. gage, with an initial pressure of only 200 lb. gage, would not be advisable. The power derived from the expansion of 3,000 lb. of steam per hour from a pressure of 200 lb. to 90 lb. would amount to about 33 kw. This obviously is not sufficient to warrant the control equipment required.

Expansion of 20,000 lb. of steam from 200 to 30 lb. gage would result in the generation of about 446 kw. per hour. Since this is not sufficient to furnish the required load, the balance of the power must be obtained through expansion of steam to a low pressure by a condenser. To generate the balance of the power, 554 kw., will require 7,800 lb. of steam per hour exhausting into a condenser having a pressure of 1 in. Hg. absolute.

In other words, the solution is to install an extraction turbine with a capacity of 1,000 kw., which will allow the extraction of 20,000 lb. of steam per hour at 30-lb. gage pressure and condense 7,800 lb. of steam per hour. The 3,000 lb. of 90-lb. steam should be obtained by reducing the high-pressure steam with a reducing valve.

A back-pressure turbine could not be used, as the exhaust steam would be greatly in excess of requirements.

One point which should not be overlooked is that the steam from an extraction turbine will not have the same heat content as the steam that has been reduced by a reducing valve. The boiler steam, and, likewise, the reduced steam, has a heat content of 1,199.2 B.t.u. per pound. The extracted steam will have a heat content of about 1,123 B.t.u. per pound, which means that the extraction steam will be of a quality of 95 per

cent. The reduced live steam would contain 60 deg. F. superheat.

Assuming the steam to be condensed at 30 lb.-gage pressure and the condensate to be returned to the boilers at the corresponding temperature, the extracted steam will have only 879.6 B.t.u. per pound available for process work, whereas the reduced steam would have 955.8 B.t.u. available. This means that if 20,000 lb. per hour of the reduced steam is required, 21,750 lb. of the extraction steam must be supplied.

H. D. Golladay.

Wisconsin Rapids, Wis.

THE present steam load on the boiler room, disregarding losses, is 53,000 lb. per hour. This consists of 30,000 lb. to the 2,000-kw. condensing unit, 20,000 lb. of 30-lb. process and 3,000 lb. of 90-lb. process steam.

Consider, first, the extraction unit, using 190 lb. gage pressure and 60 deg. superheat at the throttle, with 3-in. abs. exhaust pressure. Under these conditions, and at a load of 1,000 kw., the total steam flow is 30,000 lb. per hour, consisting of 3,000 lb. extracted at 90 lb., 20,000 lb. extracted at 30 lb., and 7,000 lb. to the condenser. The total steam load is thus increased 7,000 lb., or about 13 per cent.

If the non-condensing unit is used, its steam flow will be 42,000 lb., of which 3,000 lb. is extracted at 90 lb., 20,000 lb. of the 30-lb. pressure exhaust is used for process, and the remaining 19,000 lb. of the exhaust is blown to the atmosphere. The steam requirements in this case are increased 19,000 lb. per hour, or 36 per cent.

The extraction unit thus saves 12,000 lb. of steam over the back-pressure machine. Using a production cost of 40c. per thousand pounds of steam, the extraction machine saves $4.80 per hour, or about $15,000 per year.

It may be safely assumed that the cost of the small condenser and auxiliaries required by the extraction unit will not equal the cost of the boiler plant to produce the 23 per cent net extra steam required by the back-pressure turbine.

Thus the extraction unit would be much the better choice.

Topeka, Kan. R. H. Sogard.

A BACK-PRESSURE turbine operating from 200-lb. pressure and 150 deg. superheat to an exhaust pressure of 30 lb. would generate about 460 kw. on 20,000 lb. of steam per hour. The 150-deg. superheat is assumed, as a water rate of 15 lb. per kilowatt-hour would hardly be obtained on 200 lb. saturated steam to 28 in. vacuum.

Since the expected increase in load is 1,000-kw., the use of a back-pressure turbine would require an additional condensing unit, and it would be better to combine them in one unit of the automatic-extraction type. The small quantity of steam used at 90 lb. would hardly be sufficient to justify a separate extraction, and it should be used through a reducing valve as at present. The steam flow for the different conditions can be calculated to show this is true.

Assume the 1,000-kw. increase in capacity will operate at 60 per cent capacity factor, adding 600 kw. to the average load. The average total load will then be 2,600 kw. If this load is carried condensing, the steam requirements at 15 lb. per kilowatt-hour will be 39,000 lb. per hour. The process requirements are 23,000 lb. per hour, making total steam requirements 62,000 lb. with no extraction.

With 20,000 lb. extraction at 30 lb. the throttle flow will be about 52,000 lb. per hour, plus 3,000 lb. used through the reducing valve at 90 lb., or total requirement of 55,000 lb. per hour. The addition of the 90 lb. extraction will reduce this flow about 400 lb. per hour.

At 7,000 hr. per year operation and 8 lb. evaporation per pound of coal, the 30-lb. extraction will show a saving of about 3,000 tons coal over reducing-valve operation; adding the 90-lb. extraction will show less than 200 tons' coal saving per year, which would not justify the additional complication and investment. Russell S. Clark.

Cleveland, Ohio.

ASSUMING the steam is dry and pressures given are gage, a preliminary calculation shows that 23,000 lb. of steam expanding from 200 lb. to 90 lb., and 20,000 lb. of steam expanding from 90 lb. to 30 lb., will produce only 414 kw., at the Rankine efficiencies assumed below. Therefore a back-pressure turbine is out of the question, unless 586 kw. is to be purchased. But a double-extraction, condensing turbine will do nicely.

Of course, the turbine manufacturers are about the only ones who can tell what the Rankine efficiencies will be under these conditions. But assuming approximate efficiencies of 48 per cent from 200 lb. to 90 lb. expansion, 61 per cent from 90 lb. to 30 lb. expansion and 77 per cent from 30 lb. to 28-in. vacuum expansion, we get steam rates of 120 lb., 90 lb., and 20 lb. per kw., respectively.

The total throttle flow F that will give the desired extraction and power is found by the following equation:

$$\frac{F}{120} + \frac{F - 3{,}000}{90} + \frac{F - (3{,}000 + 20{,}000)}{20} = 1{,}000 \text{ kw.}$$

By which the throttle flow F is found to be 31,440 lb. per hour.

This shows that a bleeder turbine will be necessary to produce the desired power, and the steam going to the condenser will be only 31,440 — 23,000 = 8,440 lb. per hour.

B. G. Lowenstein.

Roxbury, Mass.

A Question for Our Readers

WE ARE operating a saw mill and there is a large, constantly burning waste pile. To obviate a large initial payment on steam-heated dry kilns, it has been suggested that a brick fireplace be built with a large number of large air tubes through which warm air might be drawn, then conveyed 80 ft. through heat-insulated pipe by fan to suitable kiln buildings. What cheap method of heat insulation of the pipe could be used? W.S.W.

Suitable answers from readers will be paid for and published in the June 17 number.

IT WOULD be better to install a condensing turbine with a single bleed at 30 pounds.

A straight back-pressure turbine at 68 per cent turbine efficiency requires $\frac{3{,}414 \times 100}{68} = 5{,}000$ B.t.u. per kilowatt-hour, and the available heat drop from steam at 200 lb. to 30 lb. is 94 B.t.u. per pound, so that the available power in this case would be $\frac{20{,}000 \times 94}{5{,}000} = 376$ kw. per hour.

Similarly, the available power from 200 to 90 lb. is

$$\frac{3{,}000 \times 40}{5{,}000} \text{ or } 24 \text{ kw.-hr.,}$$

leaving a bleed at 90 lb. obviously out of the question.

Considering a bleeder turbine with draw-off at 30 lb. and exhausting to 28 in. Hg., 376 kw. will be provided at the high-pressure end, as before, and 624 kw. will have to be developed condensing. With a total heat drop of 343 B.t.u. per pound of steam, about $\frac{624 \times 5{,}000}{343}$ or, say, 9,000 lb. per hour, will be necessary besides the process steam.

The above calculations ignore the drop in pressure in the steam lines, and are given only as a guide to the layout. An alteration to the boiler plant might be economically sound. For example, superheating the steam 200 deg. F. would give about 500 kw. from the high-pressure end, and by installing new boilers to operate at 600 lb. the power requirements might be met by a straight back-pressure turbine.

In any case, a complete answer to this type of question cannot be given without a closer study of existing conditions and eqiupment.

H. L. Balmforth,
Chief Steam Engineer,
Abitibi Power & Paper Co., Ltd.
Espanola Canal.

WHAT'S NEW IN PLANT EQUIPMENT

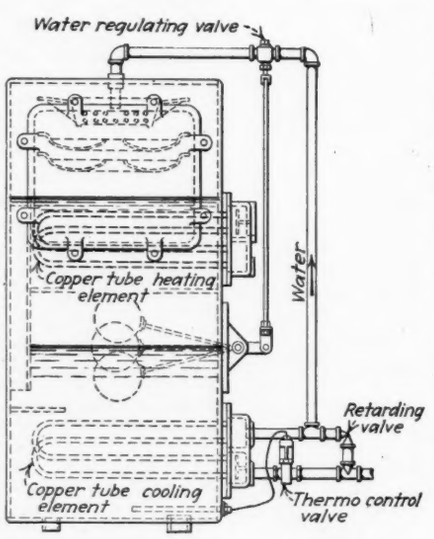
HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING, TRANSMITTING AND APPLYING THE POWER SERVICES

Deaërating Heater with Thermostatic Control for Building Services

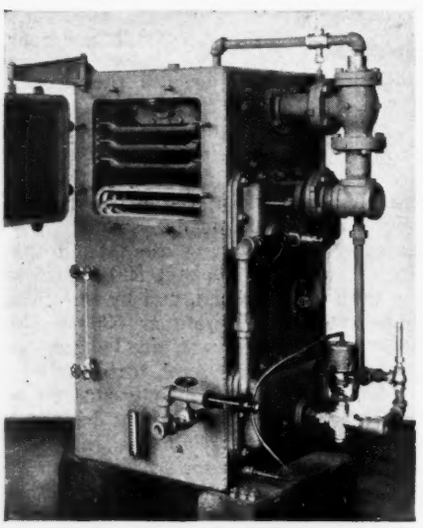
A NEW heater designed to heat and deaërate water for laboratory and other purposes in hotels, office buildings and other places where deaëration is desired to reduce or eliminate corrosion, has been brought out by the Hoppes Manufacturing Company, Springfield, Ohio.

Water is admitted to the heater by a float-controlled regulating valve and passes over trays in the upper chamber, where it is heated to within about 2 deg. of the boiling point by direct contact with steam admitted through a reducing valve. The water falls into a basin below the pans, where it is heated by steam coils to a temperature slightly above the boiling point to drive off air and gases. It then overflows and passes down a conductor pipe to the lower water chamber, where it is cooled down to the desired temperature which is usually 160 to 180 deg.

Cold water for the heater passes through the cooling coil on its way to the regulating valve, but is controlled by a thermostatic valve which prevents too much water passing through the coils by forcing it through a retarding valve connected between the inlet and outlet of the cooling coil, as shown in the line drawing.



Water connections and controlling valves



Heater with door open showing arrangement of trays and heating coil

Air and gases liberated in the heater stratify to the low point and are drawn off from the lower chamber and pass through a pipe to a vent condenser, which is a series of copper tubes submerged in the water-distributing feed trough at the top of the heater. The condenser is vented to atmosphere through the side of the heater, condensate being carried down to below the water line in the water space through a pipe.

These heaters are also built for indirect heating, in which case the coil is made large enough to heat the water to the deaërating temperature. A limited number of trays is employed in the indirect type to condense most of the vapor from water being deaërated, the remainder being condensed in the vent condenser.

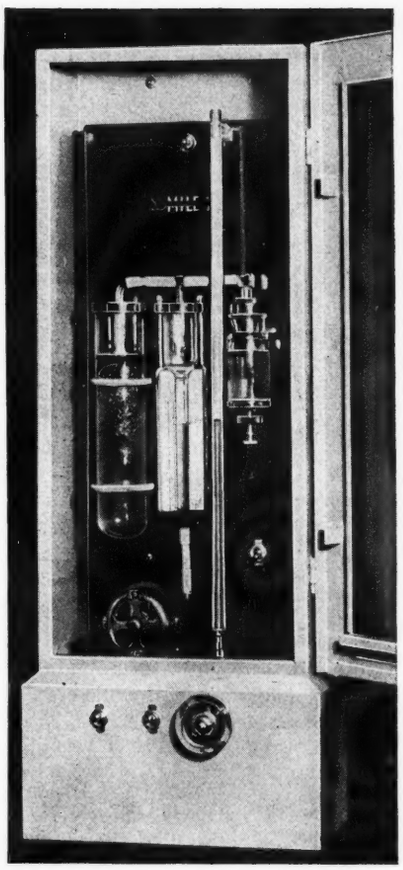
The heater illustrated is made in a number of sizes, the smallest being shown.

Fuel-Loss Indicator

AN INSTRUMENT that will indicate directly the percentage of fuel loss in any type of furnace has been developed by the Miles Engineering Company, 928 Fullerton Ave., Chicago. It is simple to operate and as it does not involve the use of, or a knowledge of, chemical symbols, readings are more readily interpreted by the average operator.

The instrument functions on the basis of excess air in the furnace gases indicated by the carbon-dioxide content. Instead of showing the percentage of carbon-dioxide in the gases, the scale is calibrated to read directly in percentage of fuel loss. The machine consists of a measuring burette connected to a caustic potash container, a motor-driven fan to draw the gases through a sampling tube inserted in the final pass of the boiler, and a crank-operated diaphragm. The equipment is mounted on a steel panel inclosed in a steel cabinet with a glass door. The instrument is permanently connected to the boiler setting, so that samples may be drawn at the will of the operator.

To obtain a reading of fuel loss, the motor-driven fan unit is set in operation to draw gas from the boiler setting through the indicating bottle at the right, and down through the measuring burette, until a representative sample of gas is obtained. Depending upon the length of the sampling tube, this operation takes from 1 to 1½ min. The motor is shut off and the gas in the burette becomes atmospherically balanced. Then by turning the crank on the diaphragm to the right colored liquid is forced upward through a capillary tube which connects the diaphragm with the measuring burette. This closes off the outlet to the fan at the bottom of the measuring burette, and automatically traps 50 c.c. of gas in the burette. The liquid continues to rise in the measuring burette as the crank is turned and forces the gas



Indicator gives direct reading of fuel loss

over into the caustic container at the left of the panel to permit the carbon-dioxide in the gases to be absorbed.

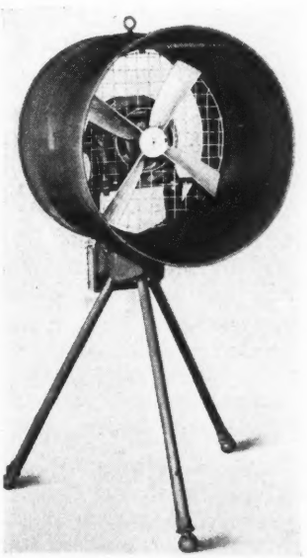
In ¼ min. the absorption process is complete. Then the crank on the diaphragm is turned to the left, allowing the liquid to recede and establish an atmospheric balance, which it does when the liquid in the measuring burette and the liquid in the static tube to the right come to a common level. The reading at the level of the liquid is taken on the celluloid fuel-loss scale back of the burette. This scale, calibrated in percentage, reads from 0 to 78 per cent fuel loss, the zero on the scale having been based on the use of 25 per cent excess air in combustion, and the 78 per cent on the use of 590 per cent excess air.

It will be seen that the operation of the indicator consists simply of starting and stopping the motor and turning the crank on the diaphragm. There are no valves to manipulate, and the atmospheric balance is automatically established. The indicator is manufactured in four models, designated A, B, D and E, all using the same system of construction, but of different mountings for various applications. Type A has three or more indicators in the same cabinet with a glass door, although all are outside operated. Gas samples are drawn from all furnaces at the same time and continuously by one motor and exhausting fan. This unit is applicable to a battery of furnaces and arranged so all readings of fuel loss may be taken at the same time.

Airplane Heat Killer for Industrial Uses

TO THE line of boiler manhole exhausters and vano blowers put out by the Coppus Engineering Corporation, Worcester, Mass., has been added two types of airplane heat killers (No. 1 and No. 2), one of which is shown in the accompanying illustration. The new units are designed to give a large volume of air at low velocity, No. 1 having a capacity of 10,500 c.f.m. at a velocity around 2,600 ft. per minute, and No. 2 a capacity of 15,600 c.f.m. at a velocity of 3,850 ft. per minute. The No. 1 unit has a 1-hp. 1,150-r.p.m. motor, which can be furnished for the following characteristics: Alternating current, 2- or 3-phase, 60-cycle, standard-voltage squirrel-cage induction type; direct current, standard-voltage, shunt-wound; and single-phase, 60-cycle, 110-220 volts interchangeable, repulsion-start induction.

To prevent recirculation of air and to improve the operating characteristics, each unit has both an inlet thimble and a diffuser whereby both incoming and outgoing air are guided. The diffuser has a baffle plate in the upper part to prevent the flow of air rising above the desired height. The No. 2 unit is equipped with a 3-hp., 1,750-r.p.m. motor.

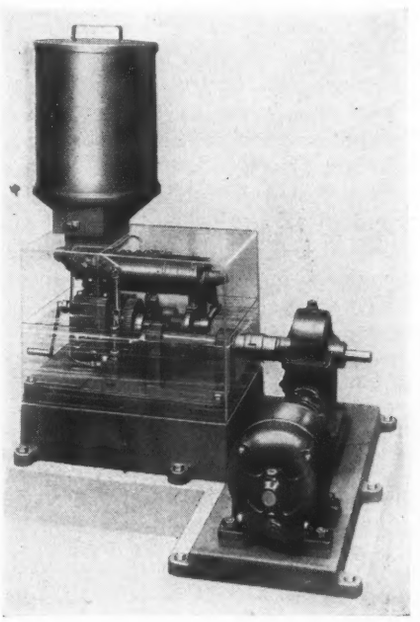


No. 1 airplane heat killer mounted on tripod

Mill-Type Grease Pump

BUILT in sizes (according to the number of feeds required) of 4, 6, 8, 10, and 12 feeds per unit, the Anderson mill-type grease pump illustrated is designed to deliver grease under any bearing pressure up to a maximum of 5,000 lb. Special sizes are made up to 24 feeds per unit.

Grease is introduced into the feeding system by a displacement pump operating a positive mechanical valve opened on the suction stroke, and closed prior to the discharge stroke. A distributor head with the requisite number of leads is directly connected to the discharge side of the pump. A ratchet attachment facilitates indexing of the head on the suction stroke of the pump, and it remains fixed during the discharge stroke,

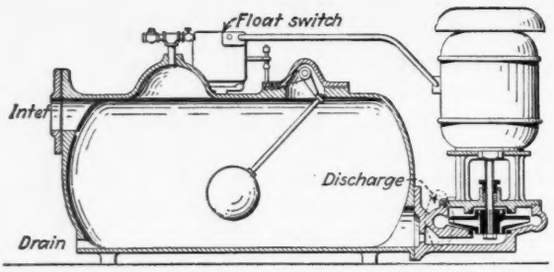


Grease pump with multiple feeds from 4 to 24 in one unit

after which it indexes to the next lead and continues in order.

Delivery lines are attached directly to the distributor head and lead to the bearings. A steam heating element is installed on the bottom of the hopper casting directly above the intake valve to facilitate handling of heavy grease during cold weather.

All running parts other than the motor and gear-reduction unit are inclosed, the entire mechanism operating in a grease or oil bath. Where more than 24 feeds or leads are needed, two or more units may be connected with a common driving mechanism to secure the desired number. The unit is put out by the Hills-McCanna Company, 2349 Nelson St., Chicago, Ill.



Cross - section of receiver and pump

Condensation Pump and Receiver

WITH a view to giving a low water line in the system at the time the float switch cuts in to start the pump, without necessity of pitting the unit, the condensation pump unit illustrated has a large capacity cast-iron receiver with the pump mounted on the end. A float switch mounted on the top of the receiver and operated by a 5-in. seamless copper float through a lever and adjustable link controls operation of the pump.

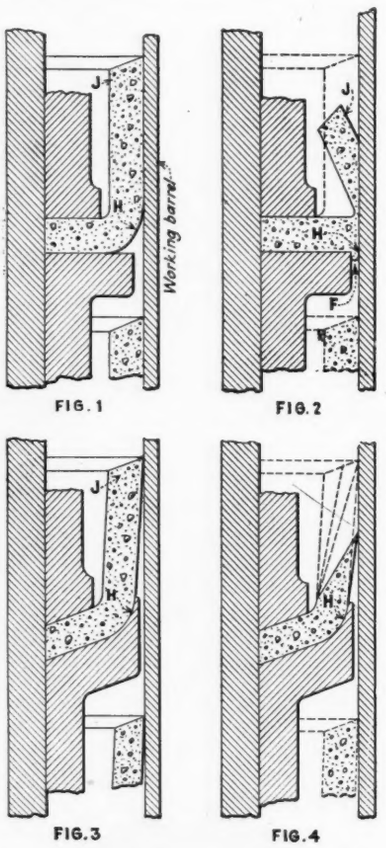
The centrifugal discharge pump, which is driven by a ball-bearing motor supported directly from the pump volute, has an inclosed bronze impeller locked on the end of the shaft against a manganese bronze sleeve which extends through the sutffing box over the shaft.

Several sizes of the unit are available, ranging in capacities from 4 to 60 gal. per minute or an equivalent radiation of 2,000 to 40,000 sq.ft., respectively. The unit is put out by the Skidmore Corporation, 1535 Dayton St., Chicago, Ill.

Cup Leather Spacing Rings for Plunger Pumps

THE accompanying illustrations show a design of spacing rings for plunger pumps developed by A. D. Cook, Inc., of Lawrenceburg, Ind., which transfers the wear on cup leathers from the heel to the vertical wall of the cup. In the past, spacing rings have had flat or shallow depressed tops. On the upstroke of the plunger pressure of the water on the rim and on the inside of the cup added to the friction between the leather and the barrel, tended to force the heel of the cup down and out. Inward buckling at the rim followed, and sand, entering between the rim and the working barrel, cut the leather and scored the barrel until, eventually, the wall of the cup broke through at the heel.

This type of cup leather is shown in Fig. 1, and the way in which it tends to wear down in Fig. 2. At *F* is a ridge which has been squeezed between the spacing ring and the barrel; at the acute angle is the ruptured wall resulting from the buckling; while the rim *J*, that should



Original and improved method of supporting cup leathers

have taken most of the wear, is practically as good as new.

In the new type of plunger, shown in Figs. 3 and 4, spacing rings have been modified to afford a seat for all of the horizontal portion of the cup leather. The depression, which curves upward and outward, has a depth greater than the thickness of the leather.

Among claims made by the manufacturer is that the only part of the new cup leather that is worn by coming into contact with the working barrel is the lip outside of the slightly flared rim (see Fig 4), and this happens only on the upstroke, when the pressure is outward. On the down stroke the wall of the cup leather tends to leave the working barrel, so that little or no wear takes place.

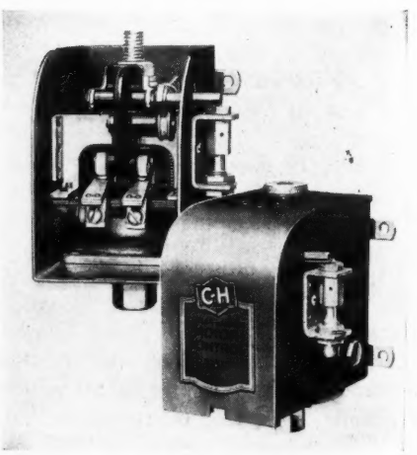
Because the leathers are molded with an obtuse instead of a right angle at the heel, it will be seen, there is less likelihood of tearing or breaking the fibers, as wear progresses from the top down. By maintaining alignment of the cup leathers the new spacing rings prevent metal-to-metal wear, and elimination of friction on the down stroke lessens the tendency of the pump rods to buckle in compression.

Small Pressure Regulator

A SINGLE-POLE pressure regulator, exceptionally small in size, is announced by Cutler-Hammer, Inc., 190 12th St., Milwaukee, Wis. This new regulator, designated as Bulletin 10006, can be used as a starting switch for motors up to 1 hp., 230 volts, alternating or direct current, or as a pilot switch in the control circuit of automatic starters for large motors. The regulator closes the circuit at low pressure and opens it at high pressure, and can be adjusted to operate at any pressure from 30 to 200 pounds.

It can be used for maintaining pressure on systems containing water, air, gas and other similar fluids. For air compressor service a small unloader device at the side of the case removes back pressure.

The inclosing case is black japanned and metal working parts are cadmium-plated to withstand moist atmospheres. Double-break silver contacts prevent pitting and insure good contact. A rubber diaphragm is used.



Open and closed views of regulator

NEWS of the FIELD

Spot News

AFTER 2½ YEARS *of construction work, the new 112,000-hp. hydroelectric plant of the Aluminum Company of America, located on the Tennessee River at Calderwood, Tenn., has been placed in operation. The development comprises a 230-ft. dam, a tunnel ½ mile long and 26 ft. in diameter, and a power house with two 56,000-hp. units operating under a 213-ft. head.*

CONTRACT *for the supply of the two new 160,000-kw. turbine-generators for the Hudson Avenue station of the Brooklyn Edison Company has been awarded to the General Electric Company. At a total cost of $18,000,000, both units are expected to be in operation in 1931. They will be of the largest single-shaft, single-unit design developed to date.*

ANNOUNCEMENT *was made last week of the organization in Delaware of the Midland Natural Gas Company to own and operate 26 natural gas properties in Pennsylvania and West Virginia. The properties total more than 15,000 acres on which are located 160 wells having a present daily production in excess of 6,500,000 cubic feet.*

ADVOCACY *by the administration of a Federal Power Commission independent of the three departments now administering matters pertaining to water resources is seen in the favorable testimony on the Parker bill last week before the House Interstate Commerce Committee by Secretary of the Interior Wilbur and Secretary of Agriculture Hyde.*

MORE THAN 100,000 *professional engineers throughout the United States will be listed by the American Engineering Council in a special census, which, it is believed, will provide one of the most comprehensive cross-sections of the profession yet obtained. It will supplement the census now being made by the government, which classifies engineers only as civil, electrical, mechanical and mining, and does not accurately describe the many divisions of the profession.*

U. S. Official Delegates Designated for World Power Conference

Seven Americans will preside at important technical sessions of second plenary meeting in Berlin

OFFICIAL DELEGATES to represent the United States Government at the World Power Conference of 49 nations to be held in Berlin, Germany, June 16 to 25, were designated at a recent meeting of the executive board of the American Committee for the conference in the rooms of the American Society of Mechanical Engineers, New York City. O. C. Merrill of Washington, chairman of the American Committee and formerly executive secretary of the Federal Power Commission, presided.

Those designated as the United States delegates and whose names will be registered with the State Department are Mr. Merrill; Professor Robert Sibley, of the University of California; Henry J. Pierce, of the Electric Bond & Share Company, New York, vice-chairman of the American Committee; H. M. Addinsell, of Harris, Forbes & Company, New York, treasurer of the American Committee; David B. Rushmore, consulting engineer, of New York; Ely C. Hutchinson, of New York, editor of *Power;* George A. Orrok, consulting engineer, of New York; Dr. H. C. Dickinson, chief of the heat and power division of the United States Bureau of Standards; Dr. H. Foster Bain, secretary of the American Institute of Mining & Metallurgical Engineers; and Scott Turner, director of the United States Bureau of Mines. The delegates will receive their credentials from the State Department.

American chairmen to preside at important sessions of the power meeting in Berlin were announced following the meeting. These men, whose names have been filed with the German committee in charge of conference arrangements, are Professor Robert Sibley, selected as chairman of Section 2, devoted to the subject "Electricity in the Crafts and Industry"; Irving E. Moultrop, chief engineer of the Edison Electric Illuminating Company, Boston, chairman of Section 7, devoted to the topic "Construction and Operation of Large Power Plants"; Col. J. P. Jackson, of the New York Edison Company, to be vice-chairman of Section 3, given over to the subject "Three-Dimensional Load Models and Current Tariffs"; W. S. Monroe, president of Sargent & Lundy, consulting engineers, of Chicago, to be vice-chairman of Section 17, given over to the topic "Co-operation of Power-Producing Plants"; Professor A. E. Kennelly, of the Harvard Engineering School, vice-chairman for Section 19, devoted to the subject "Switchgear, Including Automatic Control Apparatus for Power Stations and Remote Metering and Signalling Apparatus"; L. W. W. Morrow, editor of *Electrical World,* New York, designated as vice-chairman for Section 23, devoted to the topic "World Problems of Power Supply"; and Professor Alexander G. Christie, of the department of mechanical engineering, Johns Hopkins University, vice-chairman of Section 34, devoted to the subject "Education."

Chairman Merrill indicated that more than 200 engineers and industrialists, together with members of their families, will attend the World Power Conference as members of the United States party. Most of them will leave New York June 4 aboard the Hamburg-American liner "Resolute." Reservations for places in the American party, Mr. Merrill added, will close May 15. At the end of May the American Committee will set up temporary headquarters for the duration of the conference at the Hotel Adlon in Berlin.

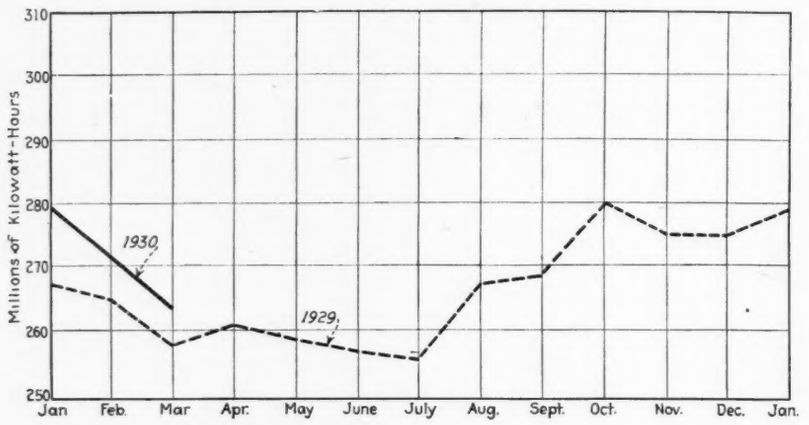
Plan New Hydro Plant for Dallas, Texas

The Dallas Power & Light Company has asked the City Commission of Dallas, Texas, to approve a plan providing for an additional expenditure of $8,587,000 during the next four years for the further expansion of Mountain Creek.

The company plans not only to build a $5,500,000 plant capable of generating 35,000 kw. but also to construct at a cost of $1,500,000 a reservoir in Mountain Creek, covering a possible 6,000-acre tract. The lake would be used not only by the new plant located there, but also would serve the existing 82,000-kw. plant in North Dallas. The company contemplates that another $1,500,000 would be required to pay for transmission lines and other equipment.

Utility Power Production Indicates Normal Conditions in Industry

THE AVERAGE daily production of electricity by public utility power plants in the United States for March was 263,400,000 kw.-hr.—about 3 per cent less than the average for February, according to figures just released by the Department of the Interior. This reduction is normal from February to March as indicated by the records from 1920 to 1929. The total output for March of this year was about 2 per cent larger than for March, 1929.



Average daily production of electricity by utility power plants

The production of hydro-electric energy in March showed a marked increase over that for February, being 40 per cent of the total production in March, compared with 35 per cent in February. Hydro-electric production is still considerably below normal, but if normal precipitation occurs throughout the country the output will tend to increase further.

According to figures received by the National Electric Light Association, electric power output is running somewhat below last year's levels throughout the Middle West, New England, upstate New York, a large part of the Rocky Mountain region and in the South. The largest, losses continue to register in the areas serving the automotive and mining industries.

The outlook for the next few months indicates that the total production of electric power may continue to run somewhat below last year's figures for the United States as a whole. This can hardly be considered, however, as a reflection of subnormal industrial activity at the present time but rather as a reflection of the extraordinary and unusually expanded conditions at this time last year. During the spring and summer of 1929 the curve of electric power production did not follow the normal seasonal line, which shows a distinct sag from April to August, but indicated a marked and unseasonal expansion. The trend of present output closely follows the usual line, and, in registering decreases below last year, does not indicate a further recession of business. It indicates, rather, a return to more normal conditions in industry.

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Unusual Features Mark New British Plant

An elaborate paper by H. A. Humphrey, D. M. Buist, and J. W. Bansall describing the pulverized-fuel, high-pressure, high-temperature power plant erected by Imperial Chemical Industries for the supply of steam and electrical energy to the factory of Synthetic Ammonia & Nitrates, Ltd., recently erected at Billingham-on-Tees, England, has just been presented before the Institution of Electrical Engineers in London.

The steam generation plant consists of eight forged-drum boilers, in two groups of four, operating under maximum conditions of 800 lb. pressure and 840 deg. F. superheated temperature, each with an evaporation of 269,000 lb. of water per hour.

The superheater is of the single-pass multiple-loop type, with elements of mild steel, operating at high velocity. The drop in pressure allowed through the superheater is 40 lb. per square inch, and normal conditions at the turbine stop-valves are 645 lb. and 833 deg. F., minimum pressure at the boilers being 700 lb. The superheated steam passes through high-pressure primary receivers between the boilers and the turbines.

The superheaters are suspended between the boiler tubes, partly exposed to the radiant heat of the furnace, with the weight taken entirely by the structure and not by any part of the boiler under pressure. Each boiler has four separate headers outside the setting, two for the saturated-steam inlet and two for the superheated-steam outlet, turned from solid, mild-steel forgings, and the approximate length of travel in each multiple-loop element is 200 ft.

The bleeder turbines exhaust at 290 lb. pressure and about 650 deg. F. to the works mains, and approximately 60 per cent of the total steam generated is taken for process while generating up to 43,500 kw. by the drop in pressure.

Phoenix Steam Plant Now in Operation

After making a test run of more than three weeks, the Central Arizona Light & Power Company's new $2,550,000 steam-electric generating plant, four miles west of Phoenix, Ariz., began operation May 1. This 24,000-hp. plant was built by the Central Arizona company in co-operation with the Salt River Valley Water Users' Association.

Workmen broke ground for the station on July 18, 1929, and had the structure virtually completed and equipment installed and ready to operate by April 3, 1930. The new station insures the farmers of Salt River Valley against any shortage of power or curtailment of water supply, and provides the city of Phoenix with power ample for any emergency.

Operation of the plant will be under the direction of Carl Hershey, plant superintendent, and Clyde Williams, chief engineer.

First Boulder Dam Expenses Approved by Bureau

Preliminary Boulder Dam expenses have been approved by the Budget Bureau to the sum of $10,660,000. Secretary of the Interior Wilbur has forwarded the estimate to Congress with a note of explanation. Here is a breakdown of the principal items which will start the mammoth project after all these years of delay:

Start of four diversion tunnels (ultimate cost $17,000,000)	$5,000,000
Spur railroad line to site	2,500,000
Initial power to drill tunnels and start job, either by purchase or building small plant	1,750,000
Confiscation of ranches and mines to be drowned out	500,000
Repayment to reclamation fund for expenses over the past ten years	385,000
Three miles of highway	300,000
Administration building and living quarters	125,000
Townsite surveys, water supply, and sanitation	100,000
Total	$10,660,000

The job starts with a spur railroad line either from Las Vegas or Chloride, Ariz. "In either case," says Mr. Wilbur, "when these spurs have reached the neighborhood of the dam a spectacular problem will be encountered: That of getting a railroad down to the bottom of the canyon 300 ft. both above and below the damsite. Beginning at a point two miles from the river, a highway must be constructed to the top of the cliffs overlooking Black Canyon damsite, a distance of three miles. This is over rough and precipitous ground."

New Shoals Bill Approved by House Committee

After deliberating for three weeks, the House Committee on Military Affairs on May 6 approved the new Muscle Shoals Bill prepared by its drafting subcommittee. Early passage by the House is foreseen. Then the bill goes directly to conference before it is submitted to the Senate again. This short cut is made possible by carrying the number of the Norris resolution, which passed the Senate, although all the Norris language is stricken out. Apparently, however, all these efforts are in vain as Senate acceptance of the House bill is thought hardly to be expected during the current session of Congress.

Technically, the bill is viewed as a good one. It kills the government ownership scheme by providing private leasing. It disqualifies power companies as bidders, thus removing the "power trust" issue. It permits the President to go ahead and get rid of the Shoals without further Congressional action.

In more detail, the bill empowers the President to appoint without confirmation a board of three eminent citizens, one of whom is identified with agriculture. The board is to appraise the property and then to lease it on the best terms possible for fertilizer, ferro-alloy, and other electro-chemical production.

Excess power is to be allocated within economic range, political subdivisions preferred. Lessees are to construct Cove Creek Dam and Dam No. 3 under the Water Power Act, and are to be partly reimbursed by federal funds for the navigation features involved and by royalties from benefits to downstream plants. Tennessee can recapture Cove Creek Dam. The federal government gets a fair rental, and annual payments which compounded at 4 per cent over 50 years will amortize the appraised value. The government can recapture temporarily for national defense or permanently in case of breach of contract.

A.S.A. Calls Conference to Standardize Gages

A general conference of manufacturers and users of pressure and vacuum gages has been called by the American Standards Association to determine whether these interests favor the establishment of a national standard for such gages. The conference will be held in the Engineering Societies Building, New York City, at 10:30 a.m. on Thursday, May 15. The conference follows a request of the American Society of Mechanical Engineers for a representative meeting at which interested groups might express their attitude toward the proposed work.

The establishment of an authoritative standard for pressure gages is considered of particular importance because of the hazards to life and property involved in the accuracy of a gage. One of the most serious hazards which the committee would attempt to eliminate is the possibility of the gages indicating zero pressure when there is actually sufficient pressure to constitute a serious danger if a boiler or tank is opened.

If the conference approves the establishment of a standard under A.S.A. auspices, a technical committee, including official representatives of producers, users, and independent technical bodies, will be organized to formulate the standard.

Large Project for Africa

Negotiations have just been completed between the Tanganyika Government and the Power Securities Corporation of London for the inauguration of what is regarded as one of the most notable development schemes of the present day in the British Empire. Major Conrad Walsh, who is returning to London after the completion of negotiations for the supply of electric power from Pangani Falls, states that big electrification works are to be established in a part of Africa where up to now nature has remained undisturbed. The company undertakes to supply power to townships stretching from the shores of the Indian Ocean to Lakes Victoria Nyanza and Tanganyika.

A.S.H.V.E. Meeting June 24-27 at Minneapolis

The semi-annual meeting of the American Society of Heating and Ventilating Engineers will be held this year in Minneapolis, Minn., from June 24 to 27, with headquarters at the Curtis Hotel. The program includes many interesting technical sessions and a full quota of entertainment features. Albert Buenger, mechanical engineer for the architectural firm of C. H. Johnson and president of the St. Paul Engineering Society, is chairman of the General Arrangements Committee.

Subjects for discussion at the technical sessions will be varied. Papers already scheduled on the tentative program include: "Wall Surface Temperatures," by A. C. Willard and A. P. Kratz; "Air Conditioning—A Vital Problem in Modern Bakeries," by W. L. Fleisher; "Oil Burning Research," by L. E. Seeley; "Control Equipment for Gas Burning Appliances," by W. E. Stark; and research papers from the laboratories of the University of Wisconsin and the University of Minnesota.

Recreational features of the program include receptions on Monday; sightseeing trips and an informal dance on Tuesday; golf tournament, bridge for the ladies, and an informal dinner on Wednesday; a ladies' garden party and the semi-annual banquet on Thursday; and a luncheon for the ladies on Friday.

News of Canada

Beauharnois orders generators—Calgary to add 18,000 hp.—Lethbridge to modernize steam plant—Two more units for Riviere des Prairies

CONTRACT for the first 200,000-hp. generator installation at the plant of the Beauharnois Power Corporation, on the St. Lawrence, has been awarded to the Canadian General Electric Company. The order consists of two 25-cycle, 50,000-hp. generators; two 60-cycle, 50,000-hp. units; and two 8,000-hp. units, which will supply power for plant purposes and also excite the bigger machines. The contract calls for delivery of the generators by spring of 1932. They will go into operation by October of the same year. Thereafter further units will be added rapidly to bring the plant up to its initial 500,000-hp. capacity.

PLANS are being completed by the Calgary Power Company, of Calgary, Alberta, for the installation of a third 18,000-hp. unit at the Ghost plant, on the Bow River, 34 miles west of Calgary. At present there are two 15,000-kva. generators and one 1,000-kva. generator for station service in operation. The company is also considering plans for the erection of a dam with regulating gates for outflow on Spray Lake to serve as a reservoir for the Ghost development in low-water periods.

THE CITY of Lethbridge, Alberta, is planning an expenditure of $200,000 to modernize its steam-electric plant to take care of the expected load for the next few years independently of outside sources of power. Two years ago last December the city and the Calgary Power Company entered into an agreement for the interchange of power for three years, the city plant operating as a stand-by in the summer months and taking power in bulk at .75c. per kilowatt-hour. The city was to operate its plant to capacity in the winter for five months, selling power to the Calgary Power Company at .85c. per kilowatt-hour. The agreement expires in April of next year. The present plan is to provide an up-to-date steam plant that will fill the city's entire requirements.

THE MONTREAL Island Power Company has brought into operation two more units at its hydro-electric plant on the Riviere des Prairies, near Montreal, Quebec. Last November three units, operating at partial load (20-ft. head), and generating 20,000 hp., were inaugurated at the plant. The entire development, which will cost $9,000,000, will eventually consist of ten units of 12,000 hp. each, with a maximum capacity of 90,000 hp. under normal conditions. It is expected that the entire ten units will be ready for service by the end of the present year.

Improved Heating Systems Financed From Savings

Financing of heating system improvements out of the savings in fuel and other operating costs is now possible through a recently organized subsidiary of the C. A. Dunham Company, Chicago. This deferred payment business will be carried on by the American Funding Corporation, having an authorized capital of $1,250,000 providing for the changeover of present systems of heating to differential system operation.

Data secured by the company's engineers concerning the saving in coal from the application of the Dunham differential vacuum heating system to existing buildings indicate that 25 per cent has proved to be a conservative figure; in some cases over 50 per cent of the previous fuel costs is now saved.

The American Funding Corporation makes possible the immediate changeover of wasteful heating systems to differential operation. The investment required is arranged through the funding corporation contract and may be paid out of operating savings.

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Obituary

WILLIAM HENRY BALDWIN, dean of hydraulic and mechanical engineers in Ottawa, Canada, and an outstanding authority on electric power equipment in the district, died in an Ottawa hospital on April 25, at the advanced age of 84 years. Mr. Baldwin was born in 1846 at Ticonderoga, N. Y., but moved to Canada at an early age. After a varied career he took up residence in Ottawa in 1890 and from then on his time was devoted to the development of electricity in the Ottawa district. He assumed charge of the power plants of the Ottawa Electric Company and the Ottawa Electric Railway. Under his direction all the important electrical units of these companies were installed. He retired from active service three years ago, but was retained by the Ottawa Electric Company in an advisory capacity.

PEDER HEINSVIK, mechanical engineer in the construction engineering department of the General Electric Company at Schenectady, N. Y., was stricken with a heart attack May 1 and died on the way to his home in Scotia, N. Y. He was 46 years of age. Though born in Boroen, Norway, Mr. Heinsvik was a citizen of the United States. He was a graduate in mechanical engineering of the Lobnitz Engineering School and the Paisley Technical School. In 1910 he entered the employ of the General Electric Company as a draftsman and had been connected with the construction engineering department continuously since early in 1923. He had been engaged in preparing engineering designs of power plants.

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Coming Conventions

American Society of Mechanical Engineers. Semi-Annual meeting at the Hotel Book-Cadillac, Detroit, Mich., June 9-12, 1930. Secretary, Calvin Rice, 33 West 39th St., New York City.

American Boiler Manufacturers Association. Annual meeting at Skytop Lodge, Cresco, Pa., May 26-28. Secretary, A. C. Baker, 801 Rockefeller Bldg., Cleveland, Ohio.

American Institute of Electrical Engineers. Annual summer convention at Toronto, Canada, June 23-27. Secretary, F. L. Hutchinson, 33 West 39th St., New York City.

American Order of Steam Engineers. Annual convention and mechanical exhibit at the Grand Fraternity Building, 1626 Arch St., Philadelphia, Pa., June 9-12. Secretary, William S. Wetzler, 6033 Jefferson St., Philadelphia, Pa.

American Society of Heating & Ventilating Engineers. Annual summer meeting at the Curtis Hotel, Minneapolis, Minn., June 23-25. Secretary, A. V. Hutchinson, 33 West 39th St., New York City.

American Society for Testing Materials. Annual meeting at Haddon Hall, Atlantic City, N. J., June 23-27. Secretary, C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

American Refractories Institute. Annual spring meeting at The Greenbrier, White Sulphur Springs, W. Va., May 19-20. Secretary, Dorothy Texter, 2202 Oliver Bldg., Pittsburgh, Pa.

Association of Iron and Steel Electrical Engineers. Annual convention and iron and steel exposition at Broadway Auditorium, Buffalo, N. Y., June 16-20. Managing director, John F. Kelly, Empire Building, Pittsburgh, Pa.

Canadian Electrical Association. Annual Convention at the Manoir Richelieu via the S.S. "St. Lawrence," June 11-13, 1930. Secretary, H. M. Lyster, 405 Power Building, Montreal, Quebec.

National Association of Practical Refrigerating Engineers. Annual convention and exhibition at the Hotel Peabody, Memphis, Tenn., Nov. 11-14. Secretary, Edward H. Fox, 5707 West Lake St., Chicago, Ill.

National Board of Boiler and Pressure Vessel Inspectors. Annual meeting at Chattanooga, Tenn., June 17-19. Secretary, C. O. Myers, 14 Commercial National Bank Bldg., Columbus, Ohio.

National District Heating Association. Annual convention at the Coronado Hotel, St. Louis, Mo., June 3-6. Secretary, D. L. Gaskill, Greenville, Ohio.

National Electric Light Association. Annual convention at Municipal Auditorium, San Francisco, Calif., June 16-20, 1930. Secretary, A. J. Marshall, 420 Lexington Ave., New York City.

National Oil and Gas Power Meeting, under auspices of A.S.M.E. Oil and Gas Power Division and Pennsylvania State College, will be held at State College, Pa., June 12-14. Chairman, L. H. Morrison, c/o *Power*, 10th Ave. and 36th St., New York City.

Second Plenary World Power Conference. Convenes at Berlin, German, June 16-25. Chairman of the American Committee, O. C. Merrill, Edmunds Building, Washington, D. C.

Universal Craftsmen Council of Engineers. Annual convention at the Hotel Kimball, Springfield, Mass., Aug. 5-8. Secretary, T. H. Jones, 33 Linden Ave., Cherrydale, Va.

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Personals

MASON T. WHITING has recently joined the Stone & Webster Engineering Corporation as engineer in the hydraulic division at the Boston office. Mr. Whiting came from Charles T. Main, Inc., with which concern he had long been connected on hydro-electric investigations and developments both in this country and Africa, where from 1920 to 1923 he was engaged, first, in reporting on power possibilities for the Union Miniere du Haut Katanga at Elizabethville, and later as head of its hydraulic department.

A. F. MORAIRTY, assistant general manager of the Central Arizona Light & Power Company of Phoenix, was recently elected president of the Arizona Utilities Association. A native of Boulder, Colo., Mr. Morairty received his preliminary schooling in Denver and was graduated from the University of Michigan in 1911 with the degree of electrical engineer.

FRANK S. CLARK of the Stone & Webster Engineering Corporation will represent his company at the World Power Conference to be held in Berlin this June. While abroad Mr. Clark will visit several European countries to study the state of the art in steam power station design.

T. A. MARSH was recently elected president of the Modern Coal Burner Company. In combustion circles Mr. Marsh is widely recognized as an authority on coals and stoker application. For the past seven years he has been western engineer and district representative of the Combustion Engineering Corporation, and previous to that he served for ten years as chief engineer of the Green Engineering Company.

JOHN H. LAWRENCE, president of Thomas E. Murray, Inc.; Charles Piez, president of the American Society of Mechanical Engineers; and D. Robert Yarnall, vice-president and treasurer of the Yarnall-Waring Company, are among those appointed as representatives of the A.S.M.E. on the American Engineering Council.

DR. WALTHER PAREY of the Verein Deutscher Ingenieure, Berlin, Germany, is now in this country working on plans for the World Power Conference. He will return to Germany with the American delegation to the conference, sailing on the Hamburg-American liner "Resolute," June 4.

R. H. DEARBORN, professor of electrical engineering at the Oregon State College, has been elected a fellow of the American Institute of Electrical Engineers. The professor received the honor as a professor of electrical engineering who has attained special distinction as expounder of the principles of electrical engineering.

Business Notes

TREADWELL ENGINEERING COMPANY, Easton, Pa., announces that G. E. Kille has been continued as Philadelphia district manager of its Hahn Division. The Philadelphia office is located in the Stock Exchange Building.

ALLIS-CHALMERS MANUFACTURING COMPANY, Milwaukee, Wis., has moved its Chicago district office to Suite 3101, Civic Opera Building, 20 North Wacker Drive.

BOILER APPLIANCE MANUFACTURING COMPANY is the new name of Wheelock-Bogue, Inc., and it is now located at 66 Pleasant St., Watertown, Mass. There is no change in the personnel or management, the firm announces, the name being changed only for the purpose of indicating the type of business.

LINCOLN ELECTRIC COMPANY, Cleveland, Ohio, announces the transfer of three men from the manufacturing district to the welder service division as follows: John C. Ardagh to the Chicago district with headquarters in the Monadnock Building, R. A. Kyle to the New York district with headquarters at 136 Liberty Street, and Robert Newton to the Cleveland district with headquarters at the factory.

COMBUSTIONEER, INC., has moved its general office and factory to Goshen, Ind.

FOSTER WHEELER CORPORATION, New York City, announces the removal of its Chicago office to 20 North Wacker Drive.

NEILAN, SCHUMACHER & COMPANY, Los Angeles, Calif., has appointed Eldrige V. Weaver sales representative for the north Texas territory with headquarters at Dallas. Roy O. Campbell, who formerly represented the company in this territory, has been made mid-continent factory representative.

THOMAS GRATE BAR COMPANY, Birmingham, Ala., announces the appointment of Thomas X. Lieb as district sales agent in Syracuse, N. Y. Mr. Lieb's address is 415 Castle Street.

THE DAMPNEY COMPANY OF AMERICA, Boston, Mass., announces that Edward L. Clark, formerly associated with the Westinghouse Electric & Manufacturing Company and the H. R. Kent Engineering Company, will be in charge of its New England territory, maintaining his offices in Boston.

WILLIAM H. WOOD, mechanical engineer of Media, Pa., announces the sale of his hydraulic and special machinery business to the READING IRON COMPANY of Reading, Pa. For any new requirements or repairs, apply direct to the Scott Foundry Department of the Reading Iron Company.

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With the SOCIETY SECTIONS

A.S.M.E., Boston Section. Inspection trip through the turbine, deep-forging and main motor departments of the Lynn Works of the General Electric Company at 1:30 p.m. on May 23.

N.E.L.A., East Central Division. Annual convention at the Hotel Statler, Cleveland, Ohio, May 20-23. Secretary, D. L. Gaskill, Greenville, Ohio.

New England States Association of the National Association of Power Engineers. Annual convention and exhibition of power machinery at the State Armory, Salem, Mass., June 19-20, 1930. Secretary, E. S. Daniels, 113½ Bridge St., Salem, Mass.

New York State Association of the National Association of Power Engineers. Annual convention and exhibition of power machinery at the Niagara Hotel, Niagara Falls, N. Y., June 12-14. Chairman, Walter B. Smith, 482 Portage Road, Niagara Falls, N. Y.

Plant Engineers' Club. Dinner meeting at the University Club, Boston, Mass., on May 21 at 6:30 p.m. Subject: "Welded Power Plant Piping," by R. H. Baker.

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Trade Catalogs

MECHANICAL STOKERS—The Stoker Manufacturers Association, of Detroit, Mich., has issued a revised edition of its Condensed Catalog of Mechanical Stokers. This 36-page publication describes and illustrates the 46 different types of stokers manufactured by the ten members of the association.

COOLING TOWERS—"How to Make Money From Water" is the title of an illustrated folder recently published by the M. H. Treadwell Company, 140 Cedar St., New York City, which describes Brownell cooling units. Another publication of the company contains information on Brownell cooling towers.

BURNERS—"Twenty-One Gas Burner Problems and Their Solutions" is the title of a 35-page, illustrated catalog (No. 21) recently issued by Natural Gas Equipment, Inc., Petroleum Securities Building, Los Angeles, Calif., which describes applications and installations of various types of gas burners. Included in the booklet are capacity-calculating charts for all types of N.G.E. gas burners used for firing boilers.

HEAT EXCHANGERS—The Schutte & Koerting Company, 12th and Thompson Sts., Philadelphia, Pa., has recently issued a 1930 edition of Bulletin No. 12H describing and illustrating the SK line of heat exchangers for liquids.

DRAFT GAGES—Bulletin 10B of late issue by the Ellison Draft Gage Company, Chicago, describes the new Ellison pointer draft gage using the stright-line movement, which is of the gasometer-bell, beam-and-pointer type and is made in single and multi-pointer units for panel or wall mounting. This gage is made with either vertical or tilted front, the latter having been designed to give, at high elevation, perfect visibility at all points of the scale.

SWITCHES—A complete line of porcelain base and industrial safety switches, motor-starting and meter-service switches and breakers and overload protective devices is described in a new catalog, No. 226, published by the Westinghouse Electric and Manufacturing Company, Mansfield, Ohio.

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Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard	New York	$2.20 @ $2.30
Kanawha	Columbus	1.35 @ 1.50
Smokeless	Cincinnati	1.75 @ 2.25
Smokeless	Chicago	2.25
S. E. Kentucky	Chicago	1.35 @ 1.60
Steam	Pittsburgh	1.50 @ 1.60
Gas Slack	Pittsburgh	.90 @ 1.10
Big Seam	Birmingham	1.60 @ 1.75
Anthracite (Gross Tons)		
Buckwheat	New York	$3.00
Barley	New York	1.40 @ 1.50

FUEL OIL

New York—May 8, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4.75@5.25c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 6c.@6.25c. per gal.

St. Louis—May 1, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.495 per bbl., or 42 gal.; 26@28 deg., $1.595 per bbl.; 28@30 deg., $1.695 per bbl.; 30@32 deg., $1.745 per bbl.; 32@36 deg., gas oil, 4.276c. per gal.; 37@40 deg., distillate, 4.98c. per gal.

Pittsburgh—Apr. 30, f.o.b. local refinery, 30@34 deg., fuel oil, 5.25c. per gal.; 36@40 deg., 5.25@5.5c.

Philadelphia — May 2, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 18 deg. plus, $1.475@$1.525 per bbl.; 23@27 deg., $2.00@$2.05 per bbl.

Cincinnati — Apr. 29, tank-car-lots, f.o.b. local refinery, 24@26 deg. Baumé, 5.25c. per gal.; 26@30 deg., 5.5c. per gal.; 30@32 deg., 5.75c. per gal.

Chicago—May 1, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 80c. per bbl.; 26@30 deg., 90c.@95c. per bbl.; 30@32 deg., $1.00@$1.05 per bbl.

Boston—May 5, tank-car lots, f.o.b., 12@14 deg., Baumé, 3.3c. per gal.; 28@32 deg., 5c. per gal.

Dallas—May 2, f.o.b. local refinery 26@30 deg., $1.25 per bbl. or 42 gallons.

New Plant Construction

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Ark., Rector—Bd. of Comrs., A. J. Glasgow, O. Bearden and R. A. Abney, will soon award contract for the construction of a power plant and electric distribution system including a Diesel oil engine and electrical equipment for Electric Light & Power Improvement Dist. No. 1. A. C. Moore, Joplin National Bank Bldg., Joplin, Mo., is engineer.

Calif., Agnews — Dept. of Public Works, Sacramento, is having plans prepared for the construction of a group of farm colony buildings including power plant, etc., here. Estimated cost $352,000. Private plans.

Calif., Coachella—Imperial Ice & Development Co., awarded contract for the construction of an ice and cold storage plant to Gay Engineering Corp., 2650 Santa Fe Ave., Los Angeles. Estimated cost $100,000.

Mass., Athol—F. W. Fuller, 148 Marble St., plans the construction of a power plant on Main St. Estimated cost $40,000. Engineer not selected.

Mass., Boston—Edison Electric Illuminating Co., 39 Boylston St., awarded contract for a 1 story, 120 x 140 ft. steam heating plant at Kneeland and Utica Sts., to W. A. and H. A. Root, 250 Stuart St. Estimated cost $600,000.

Mass., Concord—Edison Electric Illuminating Co., 70 State St., Boston, is having preliminary plans prepared for the construction of a power substation here. Estimated cost to exceed $40,000. Bigelow, Wadsworth, Hubbard & Smith, 11 Beacon St., Boston, are architects and engineers.

Mass., Hanover — City, S. W. Baker, Chn Water Comrs., is receiving bids for the construction of a water system including pumping station, elevated tank, 250,000 gal. capacity, etc. Symonds & Stevens, 70 State St., Boston, are engineers.

Mass., Ipswich — Town, H. Walton, Town Hall, awarded contract for addition to municipal power plant to T. H. Ready, Kimball Ave. Estimated cost $40,000.

Mass., Newton (br. Boston)—Dept. of Public Buildings, received lowest bid for alterations to boiler plant at Technical High School, Newtonville Section, from John MacDonald Construction Co., 250 Stuart St., Boston, $48,323.

Mass., South Braintree (br. Boston)—Norfolk County Hospital, received lowest bid for the construction of a boiler plant from John MacDonald Construction Co., 250 Stuart St., Boston. Estimated cost $40,000.

Minn., Little Falls—U. S. Property & Disbursing Officer of Minnesota, will receive bids until May 21, for a group of buildings including power house, pump house, warehouse, etc. at Camp Headquarters Building, Minnesota State Military Reservation.

Minn., St. Paul—Graham, Anderson, Probst & White, 80 East Jackson Blvd., Chicago, Ill., Archts., will receive bids until May 15, for the construction of a 32 story bank and office building including steam heating system, elevators, etc. at 4th St. for First National Bank, 346 Jackson St., St. Paul. Estimated cost $2,500,000.

Miss., Laurel—City will soon award contract for the construction of a waterworks system including pump house, pumps, etc. P. C. Klyce is engineer.

N. J., Teaneck—V. Reeser, 55 West 42nd St., New York, N. Y., Archt., will receive bids about June 1 for a 5 story addition to hospital, including steam heating and ventilation systems, boilers, elevators, etc., on Teaneck Rd., for Holy Name Hospital, Teaneck Rd. Estimated cost $800,000.

N. J., Trenton — State Bd. of Education, received lowest bid for main building and boiler house for State Teachers College, Hillwood Lakes from J. J. Morris Co., 21 North Montgomery St. Total cost $403,941.

N. Y., Brooklyn—Brooklyn Edison Co., subsidiary of New York Edison Co., Irving Pl., New York, awarded contract for two 160,000 kw. turbo-generators for steam power plant at Hudson Ave. station here to General Electric Co., River Rd., Schenectady. Estimated cost $18,000,000.

N. Y., New York — New York Steam Co., 220 Pearl St., plans additions to steam heating plant; also purchase of generating plant equipment and extensive service connections. Estimated cost $6,500,000. Work will be done by day labor and separate contracts.

Okla., Muskogee — U. S. Veterans Bureau, Arlington Bldg., Washington, D. C., will receive bids until June 10 for the construction of utility buildings, including boiler plant, etc., at U. S. Veterans' Hospital, Muskogee, Okla.

Ore., Eugene—Eugene Water Board, Spalding Bldg., is having plans prepared for the construction of a new water filtration plant and pumping plant, initial capacity 9 m.g.p.d. Estimated cost $250,000.

Ore., Portland — Comonmath Realty Co. is having plans prepared for the construction of a 27 story office building, including steam heating, ventilation and refrigeration systems, boilers, pumps, elevators, etc., at 6th and Stark Sts. Estimated cost $3,000,000. A. E. Doyle & Associates, Pacific Bldg., are architects.

Ore., Salem—G. Waters, had plans prepared for the construction of a 14 story office building, including steam heating and ventilation systems, boilers, pumps, elevators, etc., at Commercial and State Sts. Estimated cost $700,000. Knighton & Howell, U. S. Bank Bldg., Portland, are architects.

Pa., Erie—Warner Bros. Inc., 321 West 44th St., New York, N. Y., awarded contract for the construction of motion picture theatre, including refrigeration room, laundry, etc., at 8th and State Sts., here, to G. A. Fuller Co., Progress St., Pittsburgh. Estimated cost $1,500,000.

Texas—Maverick County Water Control & Improvement Dist. No. 1, Eagle Pass, Tex., plans an election to vote $1,800,000 bonds for the construction of a hydro-electric irrigation project. Private plans.

Tex., Refugio—City will soon receive bids for the construction of a new waterworks system, including well, pumping station, tank on tower, etc. Estimated cost $65,000. Hawley & Freese, 303 Frost Bldg., San Antonio, are engineers.

Tex., Rio Hondo—Rio Hondo Ice Co., c/o G. Fisher, Leavenworth, Kan., and Rio Hondo, plans the construction of a 30 ton ice plant. Estimated cost $35,000. Private plans.

Wash., Bellingham—Puget Sound Power & Light Co., Stuart Bldg., Seattle, awarded contract for the construction of a 1 story, 97 x 135 ft. service building here to F. E. Headrick. Estimated cost $40,000.

Wash., Centralia—City awarded contract for remaining work in connection with Nisqually River power project to Puget Sound Bridge & Dredging Co., Central Bldg., Seattle. $477,538.

Ont., Sudbury — Town, R. H. Martindale, Supt. of Light Dept., plans to expend, $63,752 for additional transformers, extension to lighting system, primary and secondary lines, ornamental lighting extension and power house in connection with lighting system.

Equipment Wanted

Electrical Equipment—St. Marys, Ont.—St. Marys Cement Co., J. Lind, plans to purchase electrical equipment for proposed new steel kiln, 350 ft. long. Estimated cost $50,000.

Generator Unit — Baylite Lamp & Shade Co., 152 North St., Boston, Mass., is in the market for a 5 to 15 kva. single phase, 60 cycle, 230 v. generator unit for spot welding, with 230 v. d.c. motor.

Motors — Indianapolis, Ind. — Sanitary District of Indianapolis, J. T. Jesup, Pres., will receive bids until May 27, for motors for drier and stoker drives.

Pumps, Etc.—Ontario—Dept. of Lands & Forests, Parliament Bldgs., Toronto, plans to purchase new pumps, etc. in connection with forest protection and fire fighting owners. Estimated cost $100,000.

Pump—Longport, N. J.—Bd. of Comrs., Boro Hall, plans to purchase a deep well pump and equipment for water department.

Pumps and Motors — Tipton, Okla. — City plans to purchase two 200,000 g.p.d. sewage pumps and motors for sewer dept.

Pumps, etc.—New Brunswick, N. J.—City Commission, will receive bids until May 20 for three electric motor driven centrifugal pumps, gasoline engine and accessories for proposed waterworks.

Industrial Projects

Calif., Emeryville—American Tractor Equipment Co., 5301 Horton St., awarded contract for the construction of a 1 story factory here to The Austin Co. of California, 1924 Broadway, Oakland. Estimated cost $40,000.

Fla., Panama City—International Paper & Power Co., 89 Broad St., Boston, Mass., will build a kraft paper mill, initial capacity 200 ton daily, here, to include two paper machines, each 236 in. in width. Provision is being made so that the capacity of the mill can be readily increased from 200 to 400 tons daily. Estimated cost to exceed $2,000,000. Work will be done by day labor and separate contracts. Power required for the mill will be supplied from its own power plant which will be equipped with boilers and have an electrical installation of 13,400 hp.

Ill., Chicago — Grigsby-Grunow Co., 6103 Dickens Ave., awarded contract for the construction of a 1 story, 154 x 241 ft. factory for the manufacture of the new "Majestic" electric refrigerator at 5801 Dickens Ave. Estimated cost $50,000.

Ind., Fort Wayne—Fort Wayne Knitting Co., awarded contract for the construction of a boiler house to Indiana Engineering & Construction Co. Estimated cost $225,000.

Ind., Terre Haute—American Can Co. is having plans prepared for the construction of a factory. Estimated cost $1,000,000. Private plans.

Ia., Sioux City—Benson Furniture Co., 1911 East 4th St., awarded contract for a 5 story, 50 x 110 ft. furniture factory to B. E. Short, Sioux City. Estimated cost $80,000.

Mass., Attleboro — L. G. Balfour Co., 25 County St., will build a 1 and 3 story addition to factory, Section No. 2. Estimated cost $50,000. O. M. Higgins, Park St., is architect. Work will be done by separate contracts.

Mass., Pittsfield—General Electric Co., M. Trane, Const. Supt., awarded contract for a 1 story, 60 x 120 ft. nitrogen oxygen plant on East St. Estimated cost $30,000. Private plans.

Mass., Springfield—Chapman Valve Co., will soon award contract for the construction of a plant. Estimated cost $50,000. McClintock & Craig, 458 Bridge St., are architects.

Mich., Detroit—Detroit Gray Iron Foundry Meldrum and Jefferson Ave., will soon award contract for the construction of a 1 story, 115 x 170 ft. foundry. Estimated cost $55,000. Mildner & Eisen, 925 Hammond Bldg., are architects.

O., Cleveland—Euclid Machine & Engineering Co., A. C. Smeller, 1838 Noble Rd., awarded contract for a 1 story, 70 x 100 ft. factory, boiler room and stack to R. Hansen Construction Co., 9323 Sandusky Ave. Estimated cost $50,000.

O., Cleveland—Lamson & Sessions Co., F. C. Case, Chn. of Bd., 1971 West 85th St., manufacturers of bolts and nuts, is having preliminary plans prepared for addition to factory. Estimated cost $80,000. G. S. Rider Co., Marshall Bldg., is architect.

O., Mariemont — Cincinnati Store Fixture Mfg. Co., 109 West Pearl St., plans the construction of a 1 story, 150 x 400 ft. factory on Wooster St. Estimated cost $250,000. S. E. Ponticos, 109 West Pearl St., is architect.

Pa., East Pittsburgh—Westinghouse Electric & Mfg. Co., will build a 1 story, 100 x 574 ft. manufacturing building here; also 42 x 56 ft. addition to boiler house at Trafford City. Work will be done by separate contracts.

Pa., Erie—H. F. Watson Paper Co., G. Coney, 143 East 16th St., subsidiary of Rubberite Co., 95 Madison Ave., New York, N. Y., plans the construction of a paper factory at Holland St. between 16th St. and New York Central tracks here. Estimated cost $200,000. Architect not selected. Maturity in Spring 1931.

Pa., Philadelphia—M. Kardin Box Co., 222 Pine St., manufacturers of paper boxes, awarded contract for a 4 story, 86 x 141 ft. factory at 220-26 Pine St. to A. Lamb, 812 West Wayne Ave. Estimated cost $225,000.

Pa., Ridgway — Viking Metal Products Co., awarded contract for a 1 story, 120 x 280 ft. factory to Hyde Murphy Co., Race St. Estimated cost $40,000.

W. Va., Clarksburg—D. E. McNicol Pottery Co., East Liverpool, O., awarded contract for a 1 story addition to factory including two new tunnel kilns, etc. here to Harrop Ceramic Service Co., Columbus, O. Estimated cost $350,000.

Wis., West Allis—Allis-Chalmers Co., awarded contract for a 1 story, 45 x 300 ft. factory on Greenfield St. to Meredith Bros., 253 Washington St., Milwaukee.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

CHANGES of the month, which occurred in prices of supplies, were mainly downward. Electrical supplies were more widely affected than were power-plant materials. Rubber-covered copper wire, friction tape, rubber tape, and wire solder declined in the principal buying centers during April. Manganese babbitt, used for anti-friction purposes, held its ground during a downward movement which affected all of the other grades. Demand for industrial equipment and other electrical goods is better this year than in any of the last five years except 1929.

POWER-PLANT SUPPLIES

HOSE—Quotations at New York warehouses:

	Fire Protection	50-Ft. Lengths
Underwriters' 2½-in., coupled, single jacket		(net)*60c. per ft.
Common, 2½-in., cotton, rubber-lined, 80c. per ft., list, less		50%

Air—Best grade

¾-in., per ft	3-ply....$0.30	4 ply....$0.36

Steam—Discounts from List

First grade....40%	Second grade.....45%	Third grade....50-10%

RUBBER BELTING—List price 6-in., 6 ply, $1.83 per lin.ft. The following discounts from New York warehouse list apply to rubber transmission belting in quantities of about ½ doz. rolls:

Best grade.....50%	Second grade.....60%

LEATHER BELTING—List price, 24c. per lin.ft., per inch of width, for single ply, at New York warehouses in quantities of about ½ doz. rolls:

Grade	Discount from list
Medium	30-10%
Heavy	30%

RAWHIDE LACING—For cut, best grade, 30-5%; 2nd grade, 45-5%. For laces in sides, best, 57c. per sq.ft.; 2nd, 52c., net. Semi-tanned, cut, 30-5%.

PACKING—Prices per pound at New York warehouses:

Rubber and duck for low-pressure steam, ⅛ in.	$0.90
Asbestos for high-pressure steam, ⅛ in.	1.75
Duck and rubber for piston packing	.90
Flax, regular	1.15
Flax, waterproofed	1.70
Compressed asbestos sheet	.85
Wire insertion asbestos sheet	1.20
Rubber sheet	.45
Rubber sheet, wire insertion	.75
Rubber sheet, duck insertion	.55
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.40
Asbestos wick, ½- and 1-lb. balls	.50

PIPE AND BOILER COVERING—Discounts from list at New York warehouses are as follows:

85% magnesia, high pressure		40 %
Asbestos, air cell, for low-pressure heating and return lines	4-ply	65 %
	3-ply	67½%
	2-ply	70 %

PORTLAND CEMENT—New York, $2.30 per bbl., without bags, delivered by truck to site of job. Bag charge, 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, beams and channels, 3 to 15-in.; angles, 3 to 6-in., ¼-in. thick; tees, 3-in. and larger; and plates, ¼-in. thick and heavier; all $3.30 per 100 lb. in lots up to 3,999 lb.

COTTON WASTE—The following prices are in cents per lb., at warehouse:

	New York	Cleveland	Chicago
White	13.00	16.00	15.00
Colored	9.50	12.00	12.00

WIPING CLOTHS—Prices per pound in lots of about 600 lb., for washed white wipers, as follows:

Chicago (100 lb. bales)	$0.16
New York (100 lb. bales)	.12½
Cleveland (per thousand)	38.00

LINSEED OIL—These prices are for raw oil in barrels, f.o.b., in 1 to 4 bbl. lots:

	New York	Cleveland	Chicago
Per pound	$0.15	$0.164	$0.154

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b., New York:

	Dry	In Oil
Red	$13.75	$15.25
White	13.75	14.25

RIVETS—The following quotations apply on fair-sized orders from warehouse:

Tank rivets, ⅞-in. diameter and smaller, list (Apr. 1, 1927) less 60% in full packages, for immediate delivery from warehouse stocks in New York and vicinity.

Structural rivets, ½-in., round head, per 100 lb.:

New York	$4.50*
Chicago	4.00
Pittsburgh mill	3.10

*This price is for full kegs; broken kegs are $6.00 per 100 lb.

REFRACTORIES—Prices in car-loads, f.o.b. plant:

Chrome brick, eastern shipping points	per net ton	$45.00
Chrome ore, ground, 40@50%, Cr_2O_3, in bulk	per net ton	22@25
Chrome ore, ground, 40@50%, Cr_2O_3, in sacks	per net ton	26@29
Chrome ore, crude, 40@50%, Cr_2O_3	per net ton	18.00@22.50
Magnesite brick, 9-in. straights	per net ton	65.00
Magnesite brick, 9-in. arches, wedges and keys	per net ton	71.50
Magnesite brick, soaps and splits	per net ton	91.00
Silica brick, Mt. Union, Pa	per M	43.00
Clay brick, 1st quality, 9-in. shapes, Pennsylvania	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Maryland	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Colorado	per M	40@43
Clay brick, 2nd quality, 9 in. shapes, Pennsylvania	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Maryland	per M	35@38

BABBITT METAL—Delivered in case lots from New York warehouse, on orders of 100 lb. or over, cents per pound:

Genuine, highest grade	52.00
Commercial genuine, intermediate grade	37.00
Anti-friction metal, general service	31.00
No. 4 babbitt, f. o. b.	11.00

COLD DRAWN STEEL—Shafting and screw stock, warehouse prices per 100 lb., base, are as follows:

	New York	Cleveland	Chicago
Round or hexagon	$3.40	$3.65	$3.60
Flat or square	3.90	4.15	4.10

BOILER FITTINGS—F.o.b. warehouse, Jersey City, N. J., discounts from list:

Copper ferrules	70%
Boiler flanges	65–5%
Boiler stay bolts	60%
Boiler patch bolts	20%
Boiler fitting-up bolts	45%
Pressed steel boiler lugs	10%

WROUGHT PIPE—The following basing discounts from list are for large mill lots at Pittsburgh mill:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
1 to 3	64%	52½%	1 and 1¼	31%	15%

LAP WELD

2	57%	45½%	2	23%	9%
2½ to 6	61%	49½%	2½ to 3½	28%	13%
7 and 8	58%	45½%	4 to 6	30%	17%
9 and 10	56%	43½%	7 and 8	29%	16%
11 and 12	55%	42½%	9 to 12	26%	11%

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	62%	51½%	1 to 2	34%	18%
2 to 3	63%	52½%			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	55%	44½%	2	29%	13%
2½ to 4	59%	48½%	2½ to 4	34%	20%
4½ to 6	58%	47½%	4½ to 6	33%	19%
7 and 8	54%	41½%	7 and 8	31%	17%
9 and 10	47%	34½%	9 to 12	21%	8%
11 and 12	46%	33½%			

BOILER TUBES—Standard gage, manufactured in accordance with the specifications and requirements of the American Society of Mechanical Engineers and in compliance with the rules and regulations of the U. S. Steamboat Inspection Service, from New York warehouse stock, per 100 ft.:

Size, Inches*	B.W.G.	Toncan Seamless Iron	Knobbled Charcoal Iron	Seamless Steel	Lapwelded Steel
1	13	$34.00	.....	$18.00	.....
1¼	13	37.75	.....	20.25	.....
1½	13	38.00	$38.00	19.25	.....
1¾	13	30.00	30.00	22.00	.....
2	13	26.25	26.25	20.25	$19.00
2¼	13	34.50	34.50	23.00	25.00
2½	12	34.00	34.00	26.00	24.25
2¾	12	40.50	40.50	28.50	27.50
3	12	42.50	42.50	27.00	25.50
3½	11	50.25	50.25	30.75	28.75
3½	11	54.50	54.50	33.25	31.50
4	10	67.00	67.00	40.00	38.00

These prices are based on stock lengths. If cut to special lengths billing will be based on the entire stock lengths. In addition to the foregoing, standard cutting charges are as follows:

2-in. and smaller..	$0.05 per cut	3-in.....	$0.09 per cut
2¼ and 2½ in.....	.06 per cut	3½ to 4 in..	.10 per cut

*External diameter.

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft., New-Style, A.B.C., with fibre bushing:

B. & S. Size	BX Two Cond. M. Ft.	BX Three Cond. M. Ft.	Lead Two Cond. M. Ft.	Lead Three Cond. M. Ft.
No. 14 solid....	$27.00	$42.00	$115.00	$143.00
No. 12 solid....	41.00	41.75	117.00	166.00
No. 10 solid....	57.00	72.00	137.00	189.00
No. 8 stranded..	91.00	115.00	220.00	295.00
No. 6 stranded..	135.00	163.00	295.00	.....

Coils to 1000 ft., +10%; less than coil lots, +20%.

CONDUIT—Rigid iron, price per 1,000 ft.; **ELBOWS AND COUPLINGS,** per 100 pieces, extra. New York warehouse shipment. Discount of 5 per cent for payment in 10 days; 30 days net.

Size, Inches	GALVANIZED Conduit	GALVANIZED Elbows	GALVANIZED Couplings	BLACK Conduit	BLACK Elbows	BLACK Couplings
¼	$59.96	$8.33	$4.79	$54.95	$7.21	$4.38
⅜	76.50	10.97	6.84	69.81	9.49	6.25
1	109.90	16.24	8.90	99.79	14.04	8.14
1¼	148.69	21.97	12.48	135.03	19.31	11.47
1½	177.76	29.31	15.41	161.46	25.76	14.17
2	239.20	54.71	20.55	217.25	47.20	18.90
2½	378.19	87.91	29.36	343.51	77.27	27.01
3	494.56	234.10	44.04	449.22	205.74	40.50
3½	621.96	516.92	58.74	567.64	454.09	54.02
4	758.30	597.18	73.41	693.95	524.78	67.50
4½	884.36	904.12	110.00	809.43	794.50	101.03
5	1029.65	1255.26	121.13	942.33	1103.08	111.37
6	1335.66	1560.33	176.12	1222.39	1371.20	161.93

CONDUIT BODIES AND FITTINGS—Black or galvanized.

	Less Than $15 List	$15 List to $100	$100 List and Over
Standard package	15%	20%	28%
Less than standard package	10%	15%	20%

CUT-OUTS—Following are net prices, each, in standard-package quantities:

CUT-OUTS, PLUG, SOLID, NEUTRAL OR 2-FUSE

S. P. M. L.	$0.12	D. P. D. B.	$0.31
D. P. M. L.	.16	T. P. S. B.	.35
T. P. M. L.	.27	T. P. D. B.	.47
D. P. S. B.	.16		

CUT-OUTS, N. E. C. FUSE, SOLID, NEUTRAL OR 2-FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.27	$0.70	$1.75
T. P. M. L.	.40	1.00	2.30
D. P. S. B.	.35	.87	.....
T. P. S. B.	.67	1.50	.....
D. P. D. B.	.65	1.75	.....
T. P. D. B.	1.12	3.00	.....
T. P. to D. P. D. B.	.75	2.10	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy		$19.00
No. 16 cotton reinforced heavy		21.00
No. 18 cotton reinforced light		14.00
No. 16 cotton reinforced light		18.50
No. 18 cotton Canvasite cord		15.00
No. 16 cotton Canvasite cord		18.00
No. 16 super service cord or similar (2 wire) in 1,000 ft.	$68.00	*74.00
No. 14 super service cord or similar (2 wire) in 1,000 ft.	102.00	*112.00

*Less than 1,000 ft.

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List Each
3-amp. to 30-amp.,	100	$0.15	3-amp. to 30-amp.,	100	$0.30
35-amp. to 60-amp.,	100	.30	35-amp. to 60-amp.,	100	.60
61-amp. to 100-amp.,	50	.90	65-amp. to 100-amp.,	50	1.50
101-amp. to 200-amp.,	25	2.00	110-amp. to 200-amp.,	25	2.50
201-amp. to 400-amp.,	25	3.60	225-amp. to 400-amp.,	25	5.50
401-amp. to 600-amp.,	10	5.50	450-amp. to 600-amp.,	10	8.00

Discount: Less than one-fifth standard package, 60%; one-fifth to standard package, 65%; standard package, 68%.

RENEWABLE FUSES—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.....	$0.50	$1.10	100	10
35 to 60-amp.....	1.00	1.25	100	10
65 to 100-amp.....	2.00	3.00	50	5
110 to 200-amp.....	4.00	5.00	25	5
225 to 400-amp.....	7.50	11.00	25	1
450 to 600-amp.....	11.00	16.00	10	1

REFILLS—

1 to 30-amp.....	$0.03 ea.	$0.05	100	100
35 to 60-amp.....	.05 ea.	.06	100	100
65 to 100-amp.....	.10 ea.	.10	50	50
110 to 200-amp.....	.15 ea.	.15	25	50
225 to 400-amp.....	.30 ea.	.30	25	25
450 to 600-amp.....	.60 ea.	.60	10	10

Discount Without Contract—Fuses:	
Broken cartons	Net list
Unbroken cartons	17%
Ten unbroken cartons	34%
Discount Without Contract—Renewals:	
Broken cartons	Net list
Unbroken cartons	17%
Ten unbroken cartons	34%
Discount With Contract—Fuses:	
Broken cartons	5%
Unbroken cartons	20%
Ten unbroken cartons	36%
Discount With Contract—Renewals:	
Broken cartons	Net list
Ten unbroken cartons	36%

Carton quantities may be combined to obtain maximum discounts.

FUSE PLUGS, MICA CAP—

0–30 ampere, standard package (500), per 100	$2.80
0–30 ampere, less than standard package, per 100	3.10

LAMPS—Below are present quotations in less than standard package quantities on Mazda standard, A type bulbs:

100—130 Volt Watts	General Type	Price Each	200—260 Volt Watts	Special Type	Price Each
15	A 17	$0.20	25	A 19	$0.25
25	A 19	.20	50	A 21	.25
40	A 21	.20	100	A 23	.45
50	A 21	.20	...	....	.....
60	A 21	.20	...	....	.....
100	A 23	.35	...	....	.....

Standard pkg. quantities are subject to discount of 10% from list. Annual contracts ranging from $75 to $300,000 net, allow a discount of 15 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain, separable, attachment plug	$0.18
Composition, 2-piece, attachment plug	.27
Swivel attachment plug	.12
Small size, 2-piece plug, composition	.07

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f.o.b. New York:

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Solid Duplex
14	$5.70	$7.50	$8.25	$14.80
12	7.90	9.50	10.50	18.90
10	11.00	12.75	14.50	25.50
8	15.75	18.30	20.30	36.00
6	.....	.....	28.00	.....
4	.....	.....	40.00	.....
2	.....	.....	58.00	.....
1	.....	.....	94.00	.....
0	.....	.....	103.00	.....
00	.....	.....	124.00	.....
000	.....	.....	147.00	.....
0000	.....	.....	185.00	.....

SOCKETS, BRASS SHELL—Price each, net:

	½ In. or Pendant Cap— Key	Keyless	Pull	¾ In. Cap— Key	Keyless	Pull
Standard package	$0.12	$0.10	$0.16	$0.16½	$0.14	$0.20
Unbroken carton	.14	.12	.18	.18	.16	.21
Broken carton	.16	.14	.20	.20	.18	.24

WIRING SUPPLIES—

Friction tape, ¾ in., in less than 100 lb., 30c. per lb.; in 100 lb. lots, 28c. per lb.
Rubber tape, ¾ in., in less than 100 lb., 32c. per lb.; in 100 lb. lots, 29c. per lb.
Wire solder, in less than 100 lb., 30c. per lb.; in 100 lb. lots, 28c. per lb.
Soldering paste, 2 oz. cans ..... $1.10 doz.

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c. or a.c., N.E.C.

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole Each
30	$3.50	$5.70	$9.00
60	9.00	11.00	14.00
100	14.00	17.00	29.00
200	22.00	29.00	48.00

Discounts:	
Standard package	40%
Less than standard package	35%

POWER

With which are consolidated *The Engineer* and the *Stationary Engineer*

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BOILER TUBES—Standard gage, manufactured in accordance with the specifications and requirements of the American Society of Mechanical Engineers and in compliance with the rules and regulations of the U. S. Steamboat Inspection Service, from New York warehouse stock, per 100 ft.:

Size, Inches*	B.W.G.	Toncan Seamless Iron	Knobbled Charcoal Iron	Seamless Steel	Lapwelded Steel
1	13	$34.00	.....	$18.00	.....
1¼	13	37.75	.....	20.25	.....
1½	13	38.00	$38.00	19.25	.....
1¾	13	30.00	30.00	22.00	.....
2	13	26.25	26.25	20.25	$19.00
2¼	13	34.50	34.50	23.00	25.00
2½	12	34.00	34.00	26.00	24.25
2¾	12	40.50	40.50	28.50	27.50
3	12	42.50	42.50	27.00	25.50
3¼	11	50.25	50.25	30.75	28.75
3½	11	54.50	54.50	33.25	31.50
4	10	67.00	67.00	40.00	38.00

These prices are based on stock lengths. If cut to special lengths billing will be based on the entire stock lengths. In addition to the foregoing, standard cutting charges are as follows:

2-in. and smaller..	$0.05 per cut	3-in.....	$0.09 per cut
2¼ and 2½ in.....	.06 per cut	3¼ to 4 in..	.10 per cut

*External diameter.

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft., New-Style, A.B.C., with fibre bushing:

B. & S. Size	BX Two Cond. M. Ft.	BX Three Cond. M. Ft.	Lead Two Cond. M. Ft.	Lead Three Cond. M. Ft.
No. 14 solid....	$27.00	$42.00	$115.00	$143.00
No. 12 solid....	41.00	41.75	117.00	166.00
No. 10 solid....	57.00	72.00	137.00	189.00
No. 8 stranded..	91.00	115.00	220.00	295.00
No. 6 stranded..	135.00	163.00	295.00	.....

Coils to 1000 ft., +10%; less than coil lots, +20%.

CONDUIT—Rigid iron, price per 1,000 ft.; **ELBOWS AND COUPLINGS,** per 100 pieces, extra. New York warehouse shipment. Discount of 5 per cent for payment in 10 days; 30 days net.

Size, Inches	GALVANIZED Conduit	GALVANIZED Elbows	GALVANIZED Couplings	BLACK Conduit	BLACK Elbows	BLACK Couplings
½	$59.96	$8.33	$4.79	$54.95	$7.21	$4.38
¾	76.50	10.97	6.84	69.81	9.49	6.25
1	109.90	16.24	8.90	99.79	14.04	8.14
1¼	148.69	21.97	12.48	135.03	19.31	11.47
1½	177.76	29.31	15.41	161.46	25.76	14.17
2	239.20	54.71	20.55	217.25	47.20	18.90
2½	378.19	87.91	29.36	343.51	77.27	27.01
3	494.56	234.10	44.04	449.22	205.74	40.50
3½	621.96	516.92	58.74	567.64	454.09	54.02
4	758.30	597.18	73.41	693.95	524.78	67.50
4½	884.36	904.12	110.00	809.43	794.50	101.03
5	1029.65	1255.26	121.13	942.33	1103.08	111.37
6	1335.66	1560.33	176.12	1222.39	1371.20	161.93

CONDUIT BODIES AND FITTINGS—Black or galvanized.

	Less Than $15 List	$15 List to $100	$100 List and Over
Standard package	15%	20%	28%
Less than standard package	10%	15%	20%

CUT-OUTS—Following are net prices, each, in standard-package quantities:

CUT-OUTS, PLUG, SOLID, NEUTRAL OR 2-FUSE

S. P. M. L.	$0.12	D. P. D. B.	$0.31
D. P. M. L.	.16	T. P. S. B.	.35
T. P. M. L.	.27	T. P. D. B.	.47
D. P. S. B.	.16		

CUT-OUTS, N. E. C. FUSE, SOLID, NEUTRAL OR 2-FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.27	$0.70	$1.75
T. P. M. L.	.40	1.00	2.30
D. P. S. B.	.35	.87	.....
T. P. S. B.	.67	1.50	.....
D. P. D. B.	.65	1.75	.....
T. P. D. B.	1.12	3.00	.....
T. P. to D. P. D. B.	.75	2.10	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy		$19.00
No. 16 cotton reinforced heavy		21.00
No. 18 cotton reinforced light		14.00
No. 16 cotton reinforced light		18.50
No. 18 cotton Canvasite cord		15.00
No. 16 cotton Canvasite cord		18.00
No. 16 super service cord or similar (2 wire) in 1,000 ft.	$68.00	*74.00
No. 14 super service cord or similar (2 wire) in 1,000 ft.	102.00	*112.00

*Less than 1,000 ft.

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List Each
3-amp. to 30-amp.,	100	$0.15	3-amp. to 30-amp.,	100	$0.30
35-amp. to 60-amp.,	100	.30	35-amp. to 60-amp.,	100	.60
61-amp. to 100-amp.,	50	.90	65-amp. to 100-amp.,	50	1.50
101-amp. to 200-amp.,	25	2.00	110-amp. to 200-amp.,	25	2.50
201-amp. to 400-amp.,	25	3.60	225-amp. to 400-amp.,	25	5.50
401-amp. to 600-amp.,	10	5.50	450-amp. to 600-amp.,	10	8.00

Discount: Less than one-fifth standard package, 60%; one-fifth to standard package, 65%; standard package, 68%.

RENEWABLE FUSES—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.....	$0.50	$1.10	100	10
35 to 60-amp.....	1.00	1.25	100	10
65 to 100-amp.....	2.00	3.00	50	5
110 to 200-amp.....	4.00	5.00	25	5
225 to 400-amp.....	7.50	11.00	25	1
450 to 600-amp.....	11.00	16.00	10	1

REFILLS—

1 to 30-amp.....	$0.03 ea.	$0.05	100	100
35 to 60-amp.....	.05 ea.	.06	100	100
65 to 100-amp.....	.10 ea.	.10	50	50
110 to 200-amp.....	.15 ea.	.15	25	50
225 to 400-amp.....	.30 ea.	.30	25	25
450 to 600-amp.....	.60 ea.	.60	10	10

Discount Without Contract—Fuses:	
Broken cartons	Net list
Unbroken cartons	17%
Ten unbroken cartons	34%
Discount Without Contract—Renewals:	
Broken cartons	Net list
Unbroken cartons	17%
Ten unbroken cartons	34%
Discount With Contract—Fuses:	
Broken cartons	5%
Unbroken cartons	20%
Ten unbroken cartons	36%
Discount With Contract—Renewals:	
Broken cartons	Net list
Ten unbroken cartons	36%

Carton quantities may be combined to obtain maximum discounts.

FUSE PLUGS, MICA CAP—

0–30 ampere, standard package (500), per 100	$2.80
0–30 ampere, less than standard package, per 100	3.10

LAMPS—Below are present quotations in less than standard package quantities on Mazda standard, A type bulbs:

100—130 Volt Watts	General Type	Price Each	200—260 Volt Watts	Special Type	Price Each
15	A 17	$0.20	25	A 19	$0.25
25	A 19	.20	50	A 21	.25
40	A 21	.20	100	A 23	.45
50	A 21	.20	...	....	.....
60	A 21	.20	...	....	.....
100	A 23	.35	...	....	.....

Standard pkg. quantities are subject to discount of 10% from list. Annual contracts ranging from $75 to $300,000 net, allow a discount of 15 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain, separable, attachment plug	$0.18
Composition, 2-piece, attachment plug	.27
Swivel attachment plug	.12
Small size, 2-piece plug, composition	.07

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f.o.b. New York:

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Solid Duplex
14	$5.70	$7.50	$8.25	$14.80
12	7.90	9.50	10.50	18.90
10	11.00	12.75	14.50	25.50
8	15.75	18.30	20.30	36.00
6	.....	.....	28.00	.....
4	.....	.....	40.00	.....
2	.....	.....	58.00	.....
1	.....	.....	94.00	.....
0	.....	.....	103.00	.....
00	.....	.....	124.00	.....
000	.....	.....	147.00	.....
0000	.....	.....	185.00	.....

SOCKETS, BRASS SHELL—Price each, net:

	½ In. or Pendant Cap Key	½ In. or Pendant Cap Keyless	½ In. or Pendant Cap Pull	¾ In. Cap Key	¾ In. Cap Keyless	¾ In. Cap Pull
Standard package	$0.12	$0.10	$0.16	$0.16½	$0.14	$0.20
Unbroken carton	.14	.12	.18	.18	.16	.21
Broken carton	.16	.14	.20	.20	.18	.24

WIRING SUPPLIES—

Friction tape, ¾ in., in less than 100 lb., 30c. per lb.; in 100 lb. lots, 28c. per lb.	
Rubber tape, ¾ in., in less than 100 lb., 32c. per lb.; in 100 lb. lots, 29c. per lb.	
Wire solder, in less than 100 lb., 30c. per lb.; in 100 lb. lots, 28c. per lb.	
Soldering paste, 2 oz. cans	$1.10 doz.

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c or a.c., N.E.C.

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole Each
30	$3.50	$5.70	$9.00
60	9.00	11.00	14.00
100	14.00	17.00	29.00
200	22.00	29.00	48.00

Discounts:	
Standard package	40%
Less than standard package	35%